

Sam Starkey's
The History and Development Of
Signalling On
The Railways of South Africa



A Tribute to
The Advancement of Railway Signalling in South Africa.
By Greg Hart.



Windsorton Road station in the Northern Cape. 1895
(Photo E.H. Short) T.H.L.

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The History and Development of Signalling on the Railways of South Africa.

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S. Starkey, a member of the Institution, who in 1941 was Chief Signal Engineer on S.A.R. & H., wrote it.*

The history of the railways in South Africa, in comparison with that of other large systems, does not extend over a very lengthy period, and the object of this paper is to set out in a brief form the developments which have taken place, particularly from a signalling point of View. All railways in South Africa are owned by the Government, except certain lines of small mileage, which still retain their private ownership, but are operated by the Government or under its control. The first railways there were constructed, operated by private enterprise, and built to the 4 ft. 8 ½ in. gauge. These were (a), the line from the port of Natal, known as the Point, to the town of Durban, a distance of two miles, opened in 1860 and extended a further distance of four miles to Umgeni in 1867, and (b), the line between Cape Town and Wellington, a distance of 57 miles, with a branch 5 ¼ miles long from Salt River. Two miles from Cape Town to Wynberg, opened in various stages during the years 1862 to 1864. Much discussion on the question of gauge took place when consideration was given by the Government of the Cape of Good Hope to the extension of railway communications, and having regard to the difficulties which would be encountered in the building of the railways over the mountainous parts of the country, and also the economic position of the Colony, it was decided in 1871, that the gauge of all new lines should be 3 ft. 6 in. The railways between Cape Town and Wellington, and the branch to Wynberg, were taken over in 1872 and were changed to 3 ft. 6 in. gauge in 1880 and 1881. Similarly the Government of Natal followed the policy of the Cape Government and, when construction of railways was authorised in 1875, decided that all new lines should be laid to the 3 ft. 6 in. gauge. The existing six miles of private railway between the Point and Umgeni were taken over by it in 1877 and the gauge changed in 1881.

The building of railway communications in the Colonies of the Cape of Good Hope and Natal brought about the development of the country, and gradually the lines were extended to the inland centers of Kimberley and Johannesburg, where diamond and gold mines were being developed. Up to the time of the South African War, 1899 to 1902, the republics of the Orange Free State and Transvaal had separate railway systems which were interconnected with the railways of the Cape and Natal. The majority of the railways in the Orange Free State were built, and at first worked by the Cape government. They were operated by the Free State government from January 1, 1897. Those in the Transvaal were constructed and operated by private bodies under the authority of the republican government, of these the N.Z.A.S.M. (Nedardsche Zuid-Afrikaansche Spoorweg Maatschappij), generally known as the Netherlands South African Railway Company, built and operated the major portion of the railways.

At the end of the year 1899, there were 1 990 route miles of railways in the Cape of Good Hope and 464 miles in Natal. During the progress of the South African war the railways in the Orange Free State, 442 miles. and in the Transvaal, 889 miles, were taken over and operated by the British military authorities under an administration known as the Imperial Military Railways. At the conclusion of the war, these lines became known as the Central South African Railways.

The mileages of the different railway systems at the end of 1902 were:-

Cape Government Railways 2 318 route miles, of which 18 miles were double line.

Natal Government Railways 587 route miles, of which 6 miles were double line.

Central South African Railways in Orange River Colony (Orange Free State) 463 route miles, all of which were single line.

In the Transvaal, 889 route miles of which 34 miles were double line, making a total of 4 257 miles.

These three separate railway administrations continued up to 1910, the date of the formation of the Union of South Africa, when all the railways were administered by the central government and became known as the South African Railways.

Extensions to the railway systems had been made between 1903 and 1910, so that at the date of Union in May 1910, the total route mileages of the South African Railways in the four provinces were:-

Cape: 3 329 miles (74 miles of double track)

Natal: 950 miles (8 miles of double track)

Orange Free State: 987 miles (4 miles of double track)

Transvaal: 1 725 miles (68 miles of double track)

Making a total of 6 991 miles, of which 154 miles were double track.

In a country such as South Africa where the important towns were at a long distance from each other, the distance between Cape Town and Johannesburg is 956 miles, and where sparsely populated areas existed. Considerable economy had to be exercised in routing and building the railways, in negotiating the mountainous parts of the Cape, grades of 1 in 40 with curves of 400 ft. radii were necessary, while in Natal, where the country was still more difficult, the railways were constructed with grades of 1 in 30 and curves of 300 ft. radii. Further, long detours were made to avoid tunnelling, in order to keep down the cost of construction. Under these severe conditions, only slow speeds were possible and in consequence there was little demand for improved methods in operation, such as signalling. Further, a period of depression set in about 1904, which retarded the making of improvements in the working of the railways. Since the Union of South Africa was constituted, however, when the railways came under the control of the central government, a considerable advance has been made. Deviations have been constructed to eliminate, as far as possible the severe grades and curves. The main lines have been re-laid with heavier permanent way, 96 lb. flat bottomed rails now being used in place of the 60 lb. and 80 lb. types, and general improvements made so that heavier loads may be dealt with and higher speeds maintained. The maximum speed through stations is 45 miles per hour, although this speed is exceeded on certain sections of the line outside station limits. Although the standard gauge for the railways is 3 ft. 6 in. for economical reasons, certain branch and industrial lines were built to the 2 ft. and 2 ft. 6 in. gauges. The total mileage of the railways in 1941 was 13 648, comprising 12 585 miles of 3 ft. 6 in. gauge, 954 of 2 ft. gauge, and 109 miles of 2 ft. 6 in. gauge. This total mileage includes 407 miles of private railway, of which 195 miles, built to 3 ft. 6 in. gauge, are operated by the government. The remaining 212 miles are narrow gauge industrial lines serving private interests only. Of the total mileage of 13 648, there are approximately 407 miles double track, 45 miles triple track, 7 miles quadruple track and 61 miles of quintuple track. The main trunk lines, or those which carry a frequent train service, comprise 5 100 miles and at stations on these lines interlocked signalling has been provided, with the electrical token system for single line working.

Station Arrangements.

When building the railways, the different managements generally adopted the same principle in planning the station yard arrangements. At the single line stations the main or through line was on the straight, with turn-outs for the crossing loop. Siding connections were generally provided from the loop line so that both the main and crossing loop were left free of traffic and used solely for the crossing of trains. In Natal, loop formation could not always be arranged, owing to the gradient of 1 in 30, and in these cases, the crossing places were arranged on the scissors crossing principle. The points were laid down in the immediate vicinity of the station office, each crossover connecting with a dead end siding laid on the level. The two sidings were connected with each other so that a train which had to cross another entered the siding direct and then set back into the opposite siding, so as to be in a position to start as soon as the opposing train had passed. The principle will be understood by reference to the diagram showing the signalling provided and which will be referred to later. Double line stations were arranged with the usual trailing connections to provide for emergency single line working, and it was the general policy to avoid facing points. On the double line stations in the Transvaal prior to 1899, there were no points at the stations by which trains could be side-tracked and in case of engine failure or accident, the whole length of double line between the terminating stations had to be worked as a single line. The general principles for single line stations have not been departed from to any great extent as the railways have developed, and in practically all cases, the through line is arranged on the straight. On the double lines, however, at a number of stations additional loop lines to facilitate the side-tracking of trains have been arranged.

Early Signalling.

Cape Government Railways:

In the initial stages of railway development in the Cape, fixed signals were only provided in isolated cases. We have it on record that a home signal and a distant signal were used at a station in the Cape in 1886 and it is interesting to note that the working then in use provided for the distant signal being lowered before the home signal, but only after the engine approaching the signal had whistled. It would appear from the instructions that such signalling was provided more for the protection of a shunting movement from the yard to the mainline, than for the admittance of trains, and the hand flag or lamp was the controlling signal for train movements. This is borne out from an old print showing the admittance of a train near the level crossing then in use at the entrance to Cape Town terminus. The question of interlocking of points with signals was discussed in the Cape in 1891, but it is doubtful if this referred to the interlocking of a lever frame as is now understood. It probably referred to the detection of the signals with the points. In 1896, however, an interlocking system of thirty levers was provided at Cape Town. The provision of such apparatus at other places was being considered, but the general policy was to provide a simple form of signalling, comprising of fixed semaphore signals worked by ground levers and detected with the points. Originally, the signals were placed near to the points and an outer signal, known as a distant signal but having a square-ended arm, was provided. The records show that in 1895 the distant signal arms were altered to the "swallow-tail" presumably to conform to what was then the practice on railways in England.

From about this time, however, it was decided that for stations on the single lines, two-doll bracket home signals, fixed 900 ft. from the facing points should be provided and distant signals be dispensed with, unless the approach to the home signals was obscured. Under this arrangement, shown on fig. 1, the signals were worked by pull-over levers placed in separate groups, that is to say the two levers working the "up" signals were either at the "up" facing points, or at the end of the station building nearest to the signals, while those working the "down" signals were placed at the opposite end of the building, or at the down facing points. There was no interlocking between the levers, and although the signals were detected with the respective facing points, everything depended upon the station official working the levers correctly.

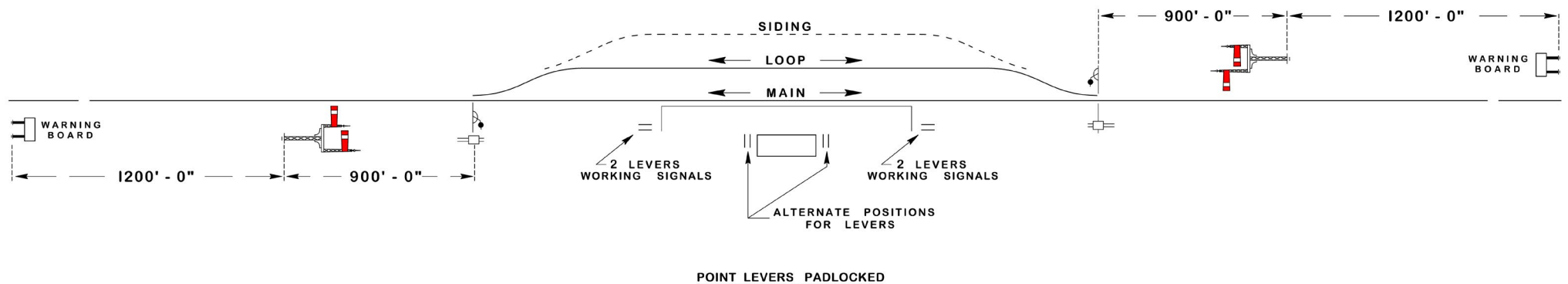


Fig. 1. First form of signalling installed at stations on the C.G.R. from about 1896.

Owing to the flat nature of the country, with very few landmarks, drivers had difficulty in locating their position relatively to a station. If a distant signal was not provided, a warning board, approximately 8 ft. by 3 ft. painted white and elevated 6 ft. above rail level was therefore placed some distance outside the home signal. This class of signalling remained in force until replaced by a full system of interlocking subsequent to 1902. The signal arms were worked by single wire and were of the lower quadrant type. They were painted in accordance with the British practice, viz. on the front red with a white stripe and on the back, white with a black stripe. Signal material was Obtained from England, being manufactured by the old signalling firms of Saxby & Farmer and McKenzie & Holland.

Natal Government Railways.

In Natal, during the early stages, the signalling comprised up and down signal arms fixed on a single post and erected in the center of the platform adjacent to the station office. The arms were worked by quadrant levers fixed to the post and were not interlocked. The arrangement is shown in fig. 2 and although the signals, which were applicable to the main line only, were not detected with the points, the regulations provided that with the signal arm at "danger", the driver of an approaching train had to stop the train at the facing points and wait there until the fixed signal was pulled off or a hand signal to admit the train was exhibited. There were a few cases where the home signal, for main line only, was placed outside the facing points and detected with the points. Also occasional use was made of the distant signal, the levers then being fixed near to the station office, but not interlocked with each other. The signalling on the Natal Government Railways was very limited. As a general practice, all train movements were conducted by hand signal. The signal arms were similar in appearance to those in use on the Cape Government Railways and all material was imported from England.

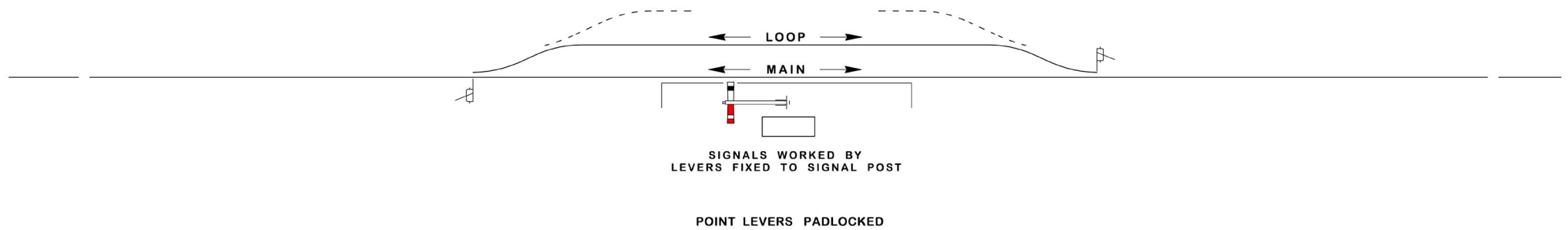


Fig. 2. First form of signalling installed on N.G.R.

Orange Free State & Transvaal.

Up to the time of the railways in the Orange Free State and Transvaal being taken over by the Imperial military authorities during the South African war, there was little or no signalling in the Orange Free State, but in the Transvaal a system of interlocked signalling had been provided by the N.Z.A.S.M. under the republican government. This signalling was in use on the trunk lines between Komatipoort (Portuguese East African border) to Pretoria, from Volksrust (Natal border) to Elandsfontein (now known as Germiston), and the local lines along the reef area, Randfontein to Springs and Elandsfontein to Pretoria. The diagram in fig. 3 shows the signalling as used on the single lines and fig. 4 is a view of a station, fig. 5 shows the arrangements at a double line station. The signalling was based on what may be called the Central European system, the bulk of the material being manufactured by the Alkmaar Iron and Foundry Works (Alkmaarsche IJzeren Metaalgieterij), Alkmaar, Holland.

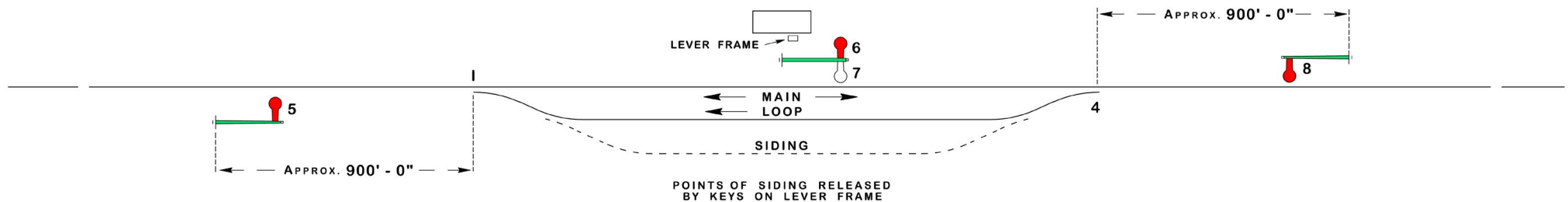


Fig. 3. Signalling installed at single line stations by the N.Z.A.S.M.

The signals and points were worked by double wires from an interlocked lever frame. This lever frame was of the wheel type, made to designs already in use in the Netherlands. Each lever being attached to a wheel 19 in. diameter, which was held in the normal and reverse position by a lug on the catch handle, and a spring being provided to keep the lug in the notch of the wheel. Fig. 6 shows a N.Z.A.S.M. type lever frame in use at Johannesburg when the railways were operated under the Central South African administration. The point levers were arranged to work in an arc of approximately 115 degrees, giving a stroke of approximately 19 in., and in their normal position stood back in the frame at an angle of 25 degrees to the vertical. The signal levers, in their normal position, were vertical and working in an arc of 90 degrees gave a stroke of approximately 12 in. In the over or reverse position, the point and signal levers lay horizontally in line with each other. Each home signal lever was provided with a trigger handle, fixed alongside it. This had to be operated before the lever could be pulled over, and similarly the trigger handle could not be restored to normal before the signal lever was in its normal position. The interlocking between signal levers was obtained through a slide plate fixed at the back of the levers. The trigger handles engaged in slots cut in the slide plate in such a manner that when a trigger handle was worked, the plate would be moved so as to lock other trigger handles, according to requirements. Where an outer signal was used as shown in fig. 3, it was released by the home signal, this being effected by the simple means of having a lug on the home lever engaging in front of a similar one on the outer lever. The interlocking between signals and points was arranged through a vertical shaft fixed at the back of the signal levers. This was operated from the trigger handle and moved a locking bar to which studs were attached, these in turn moving a spindle which coincided with notches cut in the flanges of the point lever wheels. There were limits to the locking which could be effected. No locking between point levers being provided, and efficient working was dependent to a certain extent upon springs restoring the locking bars, spindles, etc., to normal after completion of a movement.

The signal arms were all of one type, with a large rounded end, as in continental practice, and worked in the upper quadrant. A sketch of a signal arm and its fittings is shown on fig. 7. It was displayed to the left of the post as seen by an approaching driver, the opposite of the practice in the Netherlands, but otherwise the design was the same as one much used in that country at the time. The arms were painted red on the front and white on the back. The posts were tubular, painted green, and in places of ladders had round iron projector pieces on which the maintainer climbed the post. The lamp was not fixed to the post. During the day it remained in the cradle at the bottom of the post, being hoisted in position for night working. The night signals for danger and all-right were Red and Green respectively. A special slipping crank or disengaging balance lever arrangement, seen on the arm in fig. 7, ensured the latter becoming disconnected and returning to, or remaining at the danger position if a breakage occurred in the wire connections

As will be seen by the diagram shown in fig. 3, the trains crossed by the left. The locking was arranged so that in one direction, the signal (6) applied only to the main (left hand) line, whereas in the other direction the signal (7) applied to either the main line or loop, the intention being that when no crossing had to take place the train would be admitted to the main, which was the straight line. The locking also provided for the levers of all points through the station to be in their correct positions before the signal lever could be pulled. Signals were detected with the facing points and, although locking bars were not used, the fact of the signal being fixed near the station building in advance of the points provided against any movement of the latter taking place when a train was entering the station, since by the time the front portion of the train had passed the signal, its rear portion would be clear of the facing points. Although the double arm home signal, fixed about the centre of the yard, was the standard for single line crossing stations. Where there was a junction connection outside the loop facing points, separate home signals were provided and fixed so as to protect the fouling point. The instructions provided that the signal lever should not be restored to normal until the whole of the train had passed clear of the facing points, and was no doubt framed to prevent the points from being moved during the passage of the train. It is of interest to note that in a signal cabin a notice was displayed which, when translated, read: -

“THINK OF THE DANGER. IT IS PROHIBITED TO PULL POINTS UNDER A TRAIN.”

Adjusting screws were not used in the point or signal connections. Any adjustments necessary were effected by altering the length of the chain. Cut links, functioning similar to split links, were provided in the chain connections as a ready means by which the connection could be shortened, or a piece of chain inserted, should that be necessary. The point movement boxes were set at a standard distance from the points, so that all the point connecting rods were of the same dimension and interchangeable. This connecting rod was made with a sharp vertical set, almost at right angles, which took up the strain in the case of the points being incorrectly set and run through by a train, thus avoiding damage to the point movement appliance. This set in the rod also served as a means for the adjustment of the points, as a slight alteration to the set would affect the length of the rod. Precautions were also taken with the detector at the points to meet the case of a run through, as the detection was made by a lug on the underside of the signal slide, which passed through the notch in the point slide, but was clear of it in its “over” position. Should the points be run through while the opposing signal was “off”, no damage to the detector slides would result. The end of the detector, nearest to the levers, was fitted with a spiral spring which held the signal slide in position but which was not connected to it. Should the points be run through with the signal “off” resulting in the notch of the point slide being out of alignment with the detecting lug of the signal slide, the Signal could be restored to danger by the lever action, as the pulling back of the signal slide by the return wire would cause the lug, which was beveled, to ride over the point slide and the signal slide to assume its normal position. Obviously, until the points were adjusted, the detector would not permit of the signal being again pulled “off”. Double line working was in use between Johannesburg (now known as Braamfontein) and Boksburg, a distance of 17 miles, but as indicated in fig. 5, the signalling was of a very simple form. With the exception of two or three stations, there were no points to contend with, and starting signals were controlled by block instruments, this met the traffic requirements. Where points were in use, they were generally situated in advance of the starting signal.



Fig. 4.
Transvaal single line station with Dutch pattern signals.

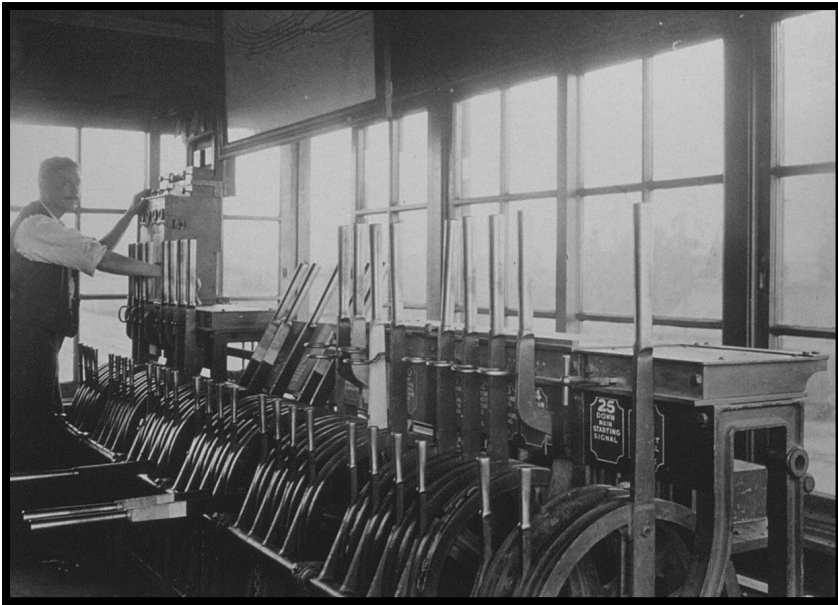


Fig. 6.
N.Z.A.S.M. type double wire lever frame in signal box at Braamfontein East (Johannesburg), C.S.A.R., showing block apparatus at far end.

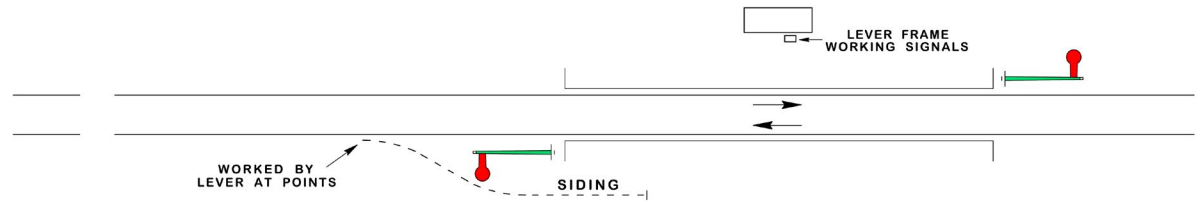


Fig. 5.
Signalling installed at double line stations by the N.Z.A.S.M.

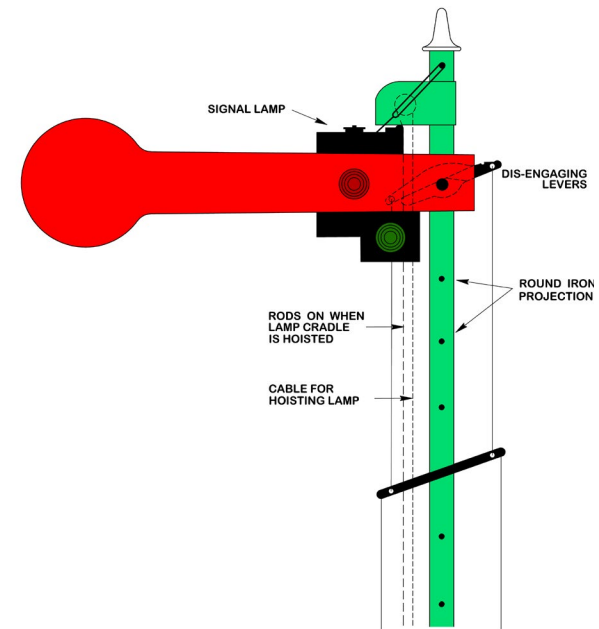


Fig. 7.
Form of signal arm used by the N.Z.A.S.M. Showing double wire attachments and disengaging levers to protect against a false clear indication should the pull wire break.

Early Methods of Working the Trains.

Single Lines.

On the single lines in the Cape and Orange Free State, permissive working was in general use, and the train working was conducted by means of train orders. Owing to the distance between telegraph stations, unattended crossing places were arranged between stations to facilitate the movement of trains. Different forms of train orders were used for “station to station”, “absolute”, “permissive” and for “interworking”. i.e. crossing at the unattended crossing places. The working to be arranged was decided upon between the officials at adjoining stations by messages passed over the Morse telegraph instruments, the tape reflecting full particulars. These particulars were entered on the train order to be handed to the driver, who was thus made aware of such train movements as would affect his train. When interworking was arranged for two opposing trains, the trainmen exchanged their orders at the crossing place. The adoption of improved methods for controlling the single line working in place of the train orders was under discussion by the Cape Railways from 1891, but not until 1900 were the Tyer’s tablet instruments put into use. “Absolute” and “absolute-permissive” instruments were installed, according to requirements, and, although progress was slow, eventually the main lines were equipped throughout with the tablet system of working.

On the Natal Government Railways, the earlier method of controlling single line working was by means of the train staff and ticket system. On the main line the stations were situated at close intervals so that as a general principle of absolute working was resorted to, but on the lesser important or branch lines permissive working was necessary as the staff stations were a considerable distance from each other. Although the train staff and ticket system did restrict or delay train movements, it avoided any misunderstanding which might arise from the use of the train order or telegraph message system. The time arrived, however, for a more up-to-date system to be adopted, and it was decided in 1900 to introduce the electric train staff system for main line working. By the end of 1903 practically all the sections on the main trunk line from Durban to the Transvaal border were being controlled by this method. Absolute instruments were provided for the greater part, where the traffic was more frequent and the stations at short distance apart, but on the northern section of the line where there was not the same necessity to adhere strictly to absolute working, the permissive staff, with attachment for seven keys, formed part of the instruments.

In the Transvaal, under the N.Z.A.S.M. administration, absolute working was in use on the single line sections, using telegraph orders, but all stations and crossing places were attended and no doubt the distances between stations and the character of the train service enabled absolute working to be maintained. The train order messages were passed over the telegraph, in a similar manner to the practice followed in the Cape, a permanent record being kept of the messages.

Double Lines.

On the double lines in the Cape, block signalling was originally carried out by means of “phonopore messages” passed over the instruments by the officials at each end of the section. Code bells were introduced in 1894, and in 1901 consideration was given to the replacement of the existing mechanical signalling by the “American system of automatic signalling” but it was found the expense could not be justified. The bell working was retained until 1905, when Tyer’s three-position one-wire needle indicating instruments were installed.

On the Natal railways, the double line comprised only four sections and the block working was controlled over the phonopore, but in 1902 Sykes two-position semaphore indicating instruments were provided.

In the Transvaal, the N.Z.A.S.M. worked the double lines by means of Siemens & Halske lock-and-block instruments. As will be seen in fig. 6, the instruments were mounted at the back of the signal levers on the locking box containing the locking slide plates. A double line section was worked "normally clear," the starting signal being normally unlocked. After the necessary bell signals had been exchanged and the train had entered the section, the starting signal lever would be restored to normal, placing the signal at danger and a plunger would be depressed at the same time as the "train on line" bell signal was given. This depressing of the plunger caused a bolt to enter the locking slide connected with the starting signal lever, locking that lever normal, and at the same time released the lock on the plunger in the apparatus at the station in the rear, thus releasing the starting signal lever at that station. The Siemens & Halske block instrument was operated by a generator and provided for two indications, viz. a white disc representing "line clear" and a red one representing "train on line." The indications showed through a small glass window in the front door of the instrument, provided with a seal. In case of failure the seal was broken and the window removed so as to permit of the indications being manipulated by hand. When the railways were administered under the Central South African Railways, these instruments were altered so that the section was "normally blocked." Electric rail treadles were provided in order to prevent a starting signal being cleared by the Signaller at the station in the rear while a train was proceeding through the section. The Siemens & Halske instruments remained in use until 1915 when they were replaced by the standard three-position lock-and-block instruments.

The Organisation for the Control of the Signalling.

At about the time of the South African war, which increased the train services, it became apparent to the railway administration that interlocked signalling would have to be introduced. Hitherto the simple form of signalling in use had been maintained by the permanent way staff, but with the introduction of interlocking it became essential that the work should be under more efficient control. We find, therefore, that in 1900 the Cape Government Railways appointed a signal inspector and in 1902 a signalling department was created on the Natal railways with an inspector in charge. These separate branches of the railway services were later recognised by the appointment in 1902 of the late Mr. P. Anderson, as the signalling officer for the Cape Government Railways, while the author (S. Starkey) took up a similar position on the Natal Government Railways in 1903. With the taking over of the railways in the Transvaal and Orange Free State by the military authorities, the services of Mr. F. Dutton, representative at Cape Town of Messrs. Saxby & Farmer, were requisitioned and a signalling department with inspector and staff was formed. Mr. Dutton remained as the signalling officer when, in 1902, the lines were taken over and administered by the Central South African Railways. These three signalling officers continued in the railway service after the railways were controlled by the one administration under the Union of South Africa, until the retirement of Messrs. Anderson and Dutton.

In 1932 the control of all the signalling on the railways was taken over by the author (S. Starkey) under the Chief Civil Engineer, and the position of Chief Signal Engineer was held by him until his retirement from the service in September 1941. After the formation of the Union of South Africa in 1910 the railways, under the one administration, were divided into systems, each of which had its own head with engineering and operating branches. Each system had its own signalling staff controlled by the Engineer, and as progress was made with the installation of interlocked signalling, signal inspectors and later, local or district signal engineers were appointed to the systems. This organisation is in force at the present time. Although in the earlier stages of signalling development, all the material was imported from England, in recent years the major portion of that needed for mechanical signalling has been manufactured in the railway workshops. Items such as wire, chain and wire pulleys were not obtainable in South Africa and therefore had to come from overseas manufacturers. Electrical signalling material has still to be imported.

Progress up to 1910.

Apart from the signalling installed by the N.Z.A.S.M. in the Transvaal, prior to 1899, interlocking was first laid down on the double line stations in the Cape Town area about 1900. There were no special features about this signalling, English practice being generally followed. It might however be interesting to mention that, in the early stages, a trial was made of using rodding instead of wire for working signals. This method was soon abandoned, however, it being realised that the expense over the cost of single wire was not justified. At Salt River, two miles from Cape Town, an interesting installation in the form of an hydraulic plant was placed in use in 1900. Illustrations of the lever frame and of the pipe connections in the lower portion of the signal cabin are shown in figs. 8 and 9. These views were taken about 1925. At the time of installation two lever frames were provided, one of 66 levers in the signal box and another of 10 levers fixed some distance away, controlling certain siding points not often used. The main lever frame comprised 14 point, 43 signal, and 9 spare levers. Of the ten levers at the subsidiary frame, two worked points, and eight were signal levers. The main pressure was at the signal box, the reservoir being located inside it. A pressure of approximately 600 lb. was maintained. The subsidiary frame was under the control of the box and did not have a separate reservoir. Subsequently, the two lever frames were combined in one of 76 levers in the box. The pumping system was operated by an oil engine, but when electric power became available later, a motor was provided to work the pumps. The oil engine was then retained as a standby. Hand pumping could also be resorted to should the maintainer not be available for starting up the oil engine plant. The lever frame was fitted with mechanical tappet locking, the locking trays being arranged in front of the levers, slightly inclined to the vertical. Copper pipes were used for the signal box connection and also at the point mechanisms, but elsewhere steel piping was used, ¼ in. dia. for the normal or main pressure, and ½ in. dia. for the abnormal pressure. The point mechanisms provided for a return indication being transmitted back to the lever frame, thus setting up a form of check locking. Two pistons formed part of a point mechanism, in alternate communication with each other. After the controlling lever had been operated approximately three-quarters of its stroke and the reverse piston had, under normal pressure, moved the points to their correct position, a bypass was opened, allowing water at the lower or abnormal pressure to pass back to the lever frame, actuating a small plunger there and releasing the lever so that it could be pulled to its full “over” position. Rams or operating pistons were used for working signals, connected direct to the balance levers in the case of semaphore or disc signals near to the signal box, but for signals some distance away, the rams were fixed opposite the box and wire connections arranged between them and the signal balance levers. Originally the water pipes were laid underground and renewals occasioned by corrosion became a heavy item. It was therefore arranged, as far as possible, to run the pipes above ground on brackets. After electric traction was introduced on the Cape Suburban lines in 1928, the piping deteriorated rapidly from electrolysis and bursts were of frequent occurrence, so that although the hydraulic system had given very satisfactory service, it was felt that more up to date plant should be installed, having in view also the remodeling work to be carried out. The hydraulic plant was therefore replaced by an all-electric installation in 1932.

The provision of interlocking at the important stations on the Cape Railways was carried out gradually. The principal installation was that provided at Cape Town at the end of 1904, to control the working into and out of the thirteen platforms which comprised the terminus. This new installation was in addition to the signal box then existing and subsequently, the latter was enlarged to meet the extensions to platforms and the remodelling of the yard, with the result that when the mechanical signalling was replaced by an all electric system in 1928 the lever frames contained 150 and 95 levers respectively. At the time it was installed the Cape Town signalling was the largest of its kind in South Africa. And it is interesting to note that included in the 150 levers were fifteen, the normal positions of which were in mid-position in the frame, by means of “push” and “pull” movements - each lever controlled two signals.

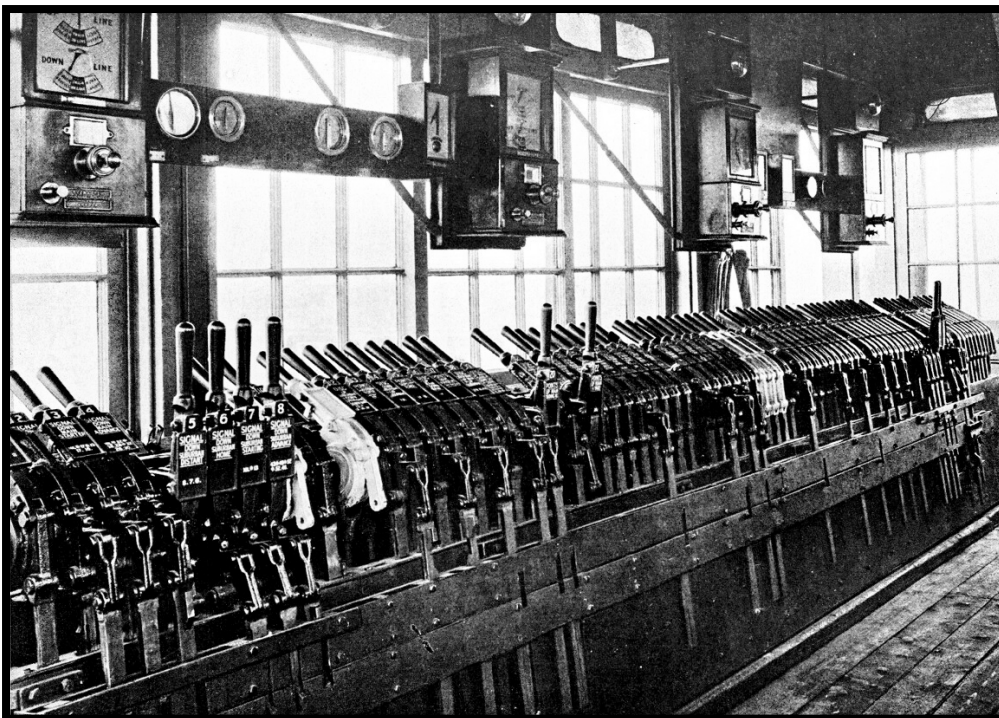


Fig. 8.

Hydraulic power frame installed at Salt River, near Capetown, C.G.R. in 1900, showing 3-position one wire block instruments, signal repeaters, etc. The hydraulic apparatus remained in use up till 1932.

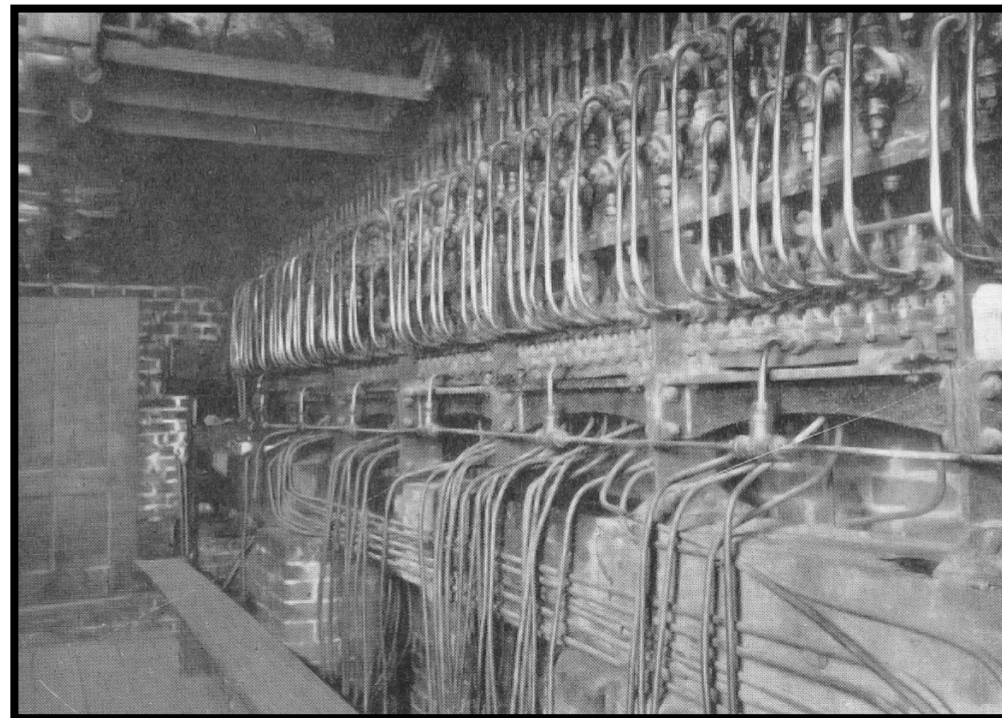


Fig. 9.

Pipe connections below hydraulic power frame at Salt River, C.G.R.
On left at top - Electric lever lock attachments.

On the Natal Railways, a simplified form of interlocking was put into use about 1901, at the Durban terminus. The points were worked from three ground frames and the signals from a centrally situated signal box, detected with the points. To set up a route the Signaller indicated by means of a code of blasts on a horn, given to the points-men at the ground frames, the direction which the train had to travel. This form of signalling was economical in initial cost, but expensive in operation, even though, in those days, Europeans were employed only at the signal box, the ground frames being worked by Indian labour. The Durban installation was remodelled in 1905, when all the points and signals were worked from one interlocked lever frame.

Early in 1903 an interlocked lever frame was put into use in Natal at a small crossing station of the scissors type, referred to earlier in this paper, the signalling being as shown in fig. 10. Originally no locking bars were fitted. At a later date, single posts with two arms were used in place of bracket signals and ground disc signals instead of point indicators. There were 23 crossing stations of this type in service on the main line, their interlocking being among the first improvements to be carried out. Under the old arrangement the points were worked by hand lever alongside them. They had to be set and their lever secured by a padlock by the European official in charge of the station before he hand-signalled the train. When two trains were crossing these operations took a little time, and as at some stations there were at least 40 booked crossings during the twenty-four hours, the provision of interlocked signalling effected a large saving in the hours of duty of trainmen by the time a train reached its depot station.

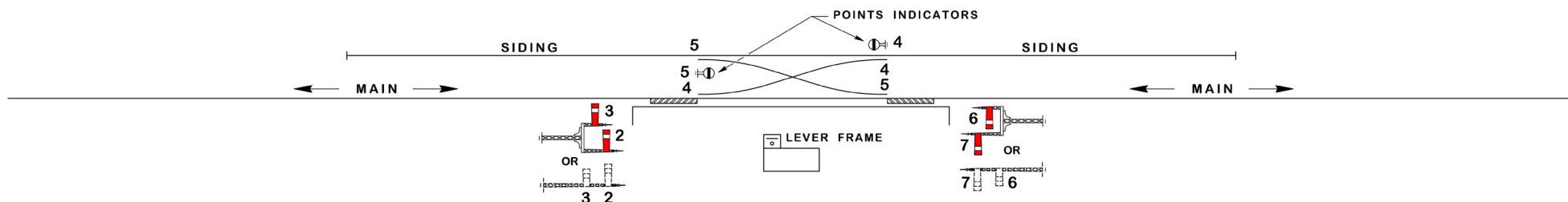


Fig. I 0. Early form of scissor type crossing station, N.G.R.

With the taking over of the railways in the Transvaal and Orange Free State by the Imperial Military Railways, the signalling erected by the N.Z.A.S.M. was remodelled to conform more to British standards, although the wheel type lever frames and the practice of operating points and signals by double wire were retained. Standards for signalling at stations were drawn up to suit the working and to obtain uniformity of practice. At the single line stations, a diagram of which is shown in fig. 11, bracket home signals, fixed approximately 60 ft. from the facing points, replaced the double arm signals originally erected at the station building, and outer home signals were provided at approximately 1 200 ft. from the home signals. An outer home signal was a “stop and draw in” signal, used mainly on single lines, and was a result of the adoption of permissive Working. It was considered that, after stopping at an outer home at danger, a driver should proceed slowly so as to bring his train within its protection rather than wait outside until it was pulled off. The diagram also shows, in dotted lines, “distant,” or as they were then termed, “through” signals on the same post as the outer homes, as in the Indian class “B” station working. These “through” signals were interlocked for the straight, or main, line and were used on those sections where non-stopping trains were run. The regulations provided that the signal, when pulled off, would denote to the driver that the section ahead was clear and the token ready to be picked up. Signals were not provided for defining the clearance points between the main and loop lines because, according to the regulations, a driver had to stop his train short of the fouling point, and responsibility was placed on the station official for seeing that the points were correctly set before he handed him the token for the section ahead.

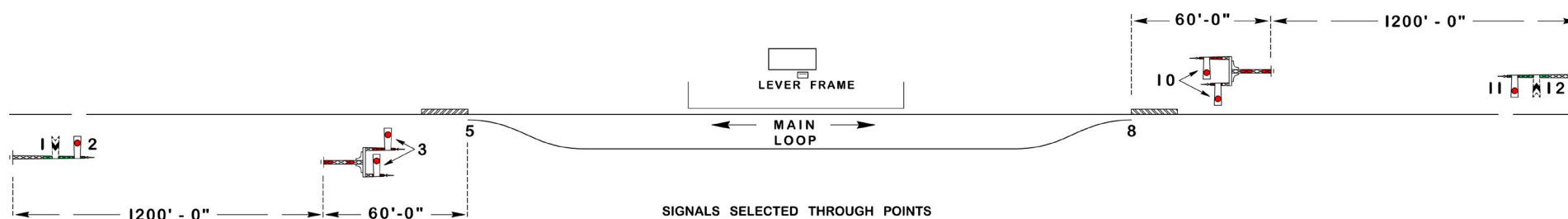


Fig. II. Arrangement of crossing station signalling adopted by C.S.A.R.

At the unattended crossing places, where the train order or token was exchanged by the trainmen themselves, two-way point indicators were fixed at the facing points, the general arrangement being shown in fig. 12. The point indicators were provided with discs for day, and lights for night, in both the facing and trailing directions. The indications were green and red in the facing, and white and red in the trailing direction, the green (facing) and white (trailing) being shown in the normal position, i.e. for the main line. The points were secured by a hand bolt lock, the key of which could only be taken out when the points were set for that line. The bolt locks were all of the same pattern and a key for unlocking them was part of the guard's equipment. A warning board for each direction was fixed at approximately 2 400 ft. from the facing points, to denote to the trainmen the proximity of the crossing place.

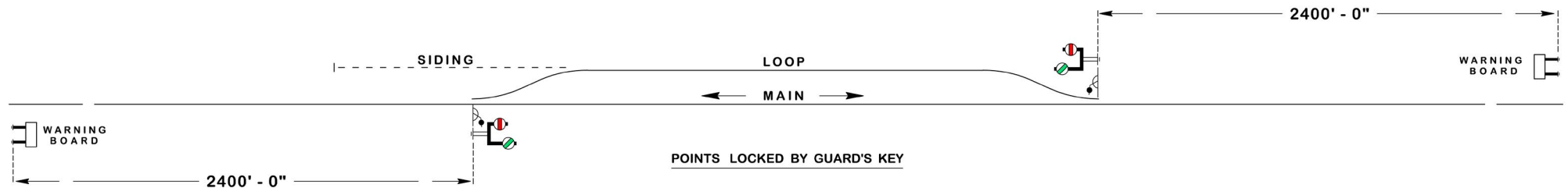
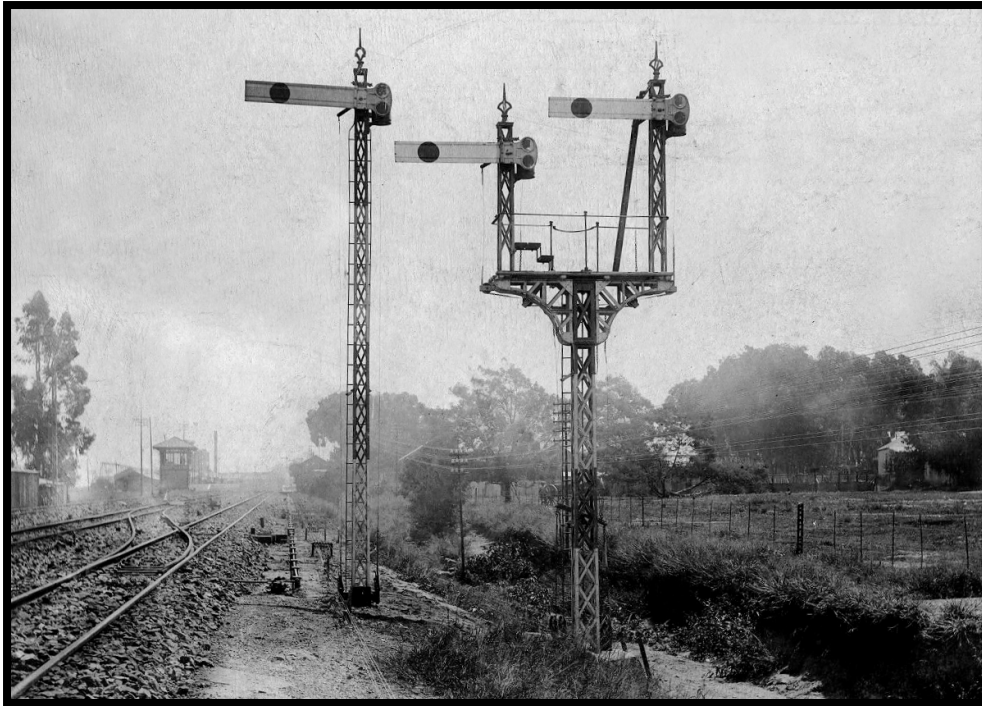


Fig. 12. Unattended crossing place on C.S.A.R., with points locked by guard's key.

The double line signalling was arranged on the generally accepted principles, "starting", "home" and "through" or "distant" signals being provided.

Distinctive Features of the Signals and Levers.

Although generally the signals in the Cape and Natal conformed to British practice, the C.S.A.R. retained some of the features in use under the old Transvaal administration. As mentioned previously, the latter used a signal arm with a large rounded end or disc, painted red in front and white at the back, the signal posts being painted green. The C.S.A.R. altered the signal arm to be square-ended and painted its front white with a red disc and its back, black with a white disc. The distant or "through" signal arm was fish-tailed and painted white with a red fishtail on the front and black with white fishtail on the back. The signal posts were painted with distinctive colours, viz :- white for starting and advanced starting signals, red and white alternately for home signals, green for outer home signals (single lines), and top half green and bottom half white for "through" or distant signals. This system of painting the signal posts in various styles was adopted to assist drivers in distinguishing the class of signal they were approaching, particularly in the case of the outer home, as its arm was square ended, the same as a home signal arm. At night time, however, the "through" signal displayed a yellow light in the "on" position, but all other signals showed red lights when normal. This is apparently the earliest instance of the yellow light being used for main line service in the British Empire: When a signal was cleared, a green light was seen. Fig 13 illustrates some C.S.A.R. signals, the appearance of which was quite distinctive.



George Gogh Home Signals.



Denver Home Signals.

Fig. 13.

**Upper quadrant semaphore signals of the type adopted by the C.S.A.R.
The front faces of the arms were white with a red disc mark.**

The signal levers were painted the same colour as the signal posts, according to the signal they worked, lead colour being used for spare levers. The other levers were painted according to the practice generally known, viz :- black for points, blue for facing point lock, and blue & black for economical facing points and lock.

Operation of Points and Signals.

The double wire system of working points and signals was used only by the N.Z.A.S.M., with the Cape and Natal administrations working points by rodding and signals by single wire. The C.S.A.R. retained the double wire system, but when resignalling the stations in the Reef (Johannesburg) area, rodding was used or working the points and locks. The upper quadrant signal arm was retained and double wire working for the signals. The C.S.A.R. also followed the practice of the N.Z.A.S.M. in providing a slipping crank arrangement as a part of the signal fittings to ensure the signal arm returning to danger should a breakage occur in either of the signal connections.

Train Working Methods (1903 to 1910).

From 1903 to 1910 very little change had taken place on the Cape and Natal railways in the methods used for working trains on single or double lines. Tyler tablet instruments, for absolute and permissive working, were being installed on the main single line sections in the Cape and Webb and Thompson's electric train staff instruments were in use on the main lines in Natal. On branch lines the train order system was employed in the Cape, but the Natal railways used the train Staff and ticket system. A portion of the Cape double line section was worked on the permissive system, controlled by Tyler's two-position semaphore permissive block instruments, arranged to permit of three trains only being worked permissively in the one direction. For absolute working Tyler's three-position needle absolute block instruments (indicating only) were used. The double line working in Natal was controlled through Sykes' two-position semaphore ("double arm bell") absolute block instruments (indicating only).

In the Transvaal and Orange Free State, the C.S.A.R. had adopted tablet instruments. absolute and permissive, on certain sections of single lines, the electric train staff, in use on the Natal railways, being continued on the line connecting the Natal border with the reef area, with provision for permissive working. The train order system continued to be used for unimportant main lines and branch lines.

Between 1902 and 1910 the double lines in the reef area had been extended and except for the sections controlled by the Siemens and Halske instruments, originally installed by the N.Z.A.S.M., block working was obtained by means of verbal messages passed over the phonopore. Subsequently on certain of these sections, Tyler's double line permissive block instruments were used, but as absolute working was still to be retained the instruments were altered to provide for one train only in each direction being accepted. A trial was made of a tablet exchanging apparatus at one of the stations between Germiston and Pretoria, where a fast train service was in operation. The equipment was not considered satisfactory for general adoption and the practice of exchanging the train tablet or staff by hand has continued.

The Developments after 1910. Standardisation.

The foregoing sets out a brief picture of the signalling and methods of train working up to the time of the establishment of the Union of South Africa in 1910, when the three separate railway concerns became merged under one administration, among the many items which had then to be decided was the adoption of suitable standards for signalling and train working. Hitherto the electrical departments of the Cape Government and Central South African Railways had control of the electrical side of signalling; in Natal the work was carried out by the officials of the Post Office. The signalling officers were, however, consulted on electrical signalling matters and thus there was a certain amount of co-ordination, in both the mechanical and electrical work. In order to arrive at standards, a conference of the signalling and electrical officers of the old administrations was held in October, 1910, when draft proposals were arrived at. These, with slight modifications, were approved and have formed the basis for all signalling since provided. It was agreed that the method of operating points by double wire, used in the Transvaal, was satisfactory and particularly suitable for the single line crossing stations. The wheel type lever frame was therefore accepted as a standard, and for such stations where rod working of the points would be the more suitable, it was decided that the duplex tappet type of lever frame which provided for catch handle locking and was originally manufactured by Saxby & Farmer, should be adopted. This type of frame was in use in the Cape and Transvaal, but the lever frames used in Natal provided for lever locking only. It has previously been mentioned that on the C.G.R. and N.G.R. the signal arms worked in the lower quadrant and those on the C.S.A.R. in the upper quadrant. There was a diversity of opinion as to which was the better arrangement, and the old arguments as to the counter balancing of the signal arm in order that it would return to danger in case of a breakage in the connection, were advanced. Among drivers too there were different views as to which was the better signal.

At the time there were 1750 lower quadrant and 900 upper quadrant arms, and although a large number of the former could be converted to the upward movement there were a number which could not. Thus the expense would be greater if the upper quadrant arm were adopted as standard than if the lower quadrant type were chosen. Bearing in mind, however, that the general tendency on other railways was to use the upper quadrant signal, the General Manager decided that, in spite of the extra cost of converting the existing arms, it should be made the standard, and subsequent experience has shown this decision to have been the correct one.

The signalling standards provided for the outer home signal (stop and draw in), as used by the C.S.A.R., but it was decided to use a pointed arm to avoid confusion with the home or square ended arm. All arms were to be painted, Red (Vermilion) on the front with White stripe, vee or fishtail, according to the class of signal, and White on the back, with Black stripe, vee or fishtail. All signal posts were to be painted white. Double wire working for signals, as a general standard was not retained, the recognised single wire working being adopted. In the case of signals at a long distance or where difficulty, due to detection, is experienced in working home signals, the double wire working is, however, still resorted to while retaining the existing practice of point operation by 1 ¼ in. round rodding, it was agreed that double wire should also be used, particularly for single line stations. The double wire system, as originally used by the N.Z.A.S.M., had been developed under the C.S.A.R. administration, with the object of making the point gear as simple as possible and enabling the locking bar to be worked economically with the points. Further experiments in the working have been made in recent years and fig. 14 shows what is now the standard arrangement for the economical working of points and locking bar. This sketch also shows a facing point bolt lock worked independently of the locking bar, which is the usual practice, but in certain cases the locking bar and facing point bolt lock are worked together, as shown in dotted lines. It should be noted that compensators were not used in the original double wire working.

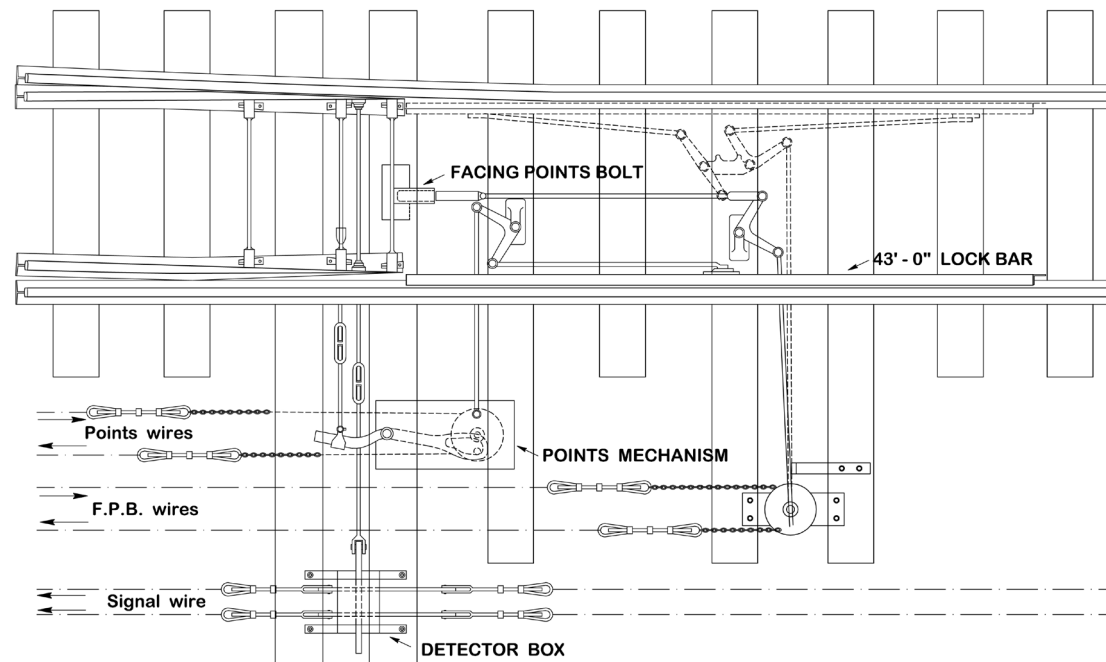


Fig. 14. Double wire point and lock layout, as developed from equipment originally installed in the Transvaal.

Although they are used on some European railways and at certain stations on British railways, experience has shown that it is not necessary to adopt any form of compensation beyond that provided by the escapement in the rod connection at the point movement box. Provision is not made for any disconnection to be brought about should the points be run through. This is not of frequent occurrence and in case of damage to the points, reliance is placed on the point lock and detector. The wheels, chains, pulleys and other details of Wire connections are the same for point as for signal working. The maximum distance at which points are worked by double wire is 1 500 ft., but this distance is reduced where local conditions necessitate the use of corner or angle wheels in the connections. Generally the signalling standards, as first decided upon, satisfactorily met the conditions of working and although they were revised in 1936, to provide for additional facilities at stations and for level crossing protection, the general principles originally adopted were not departed from.

Unattended Crossing Places.

The crossing places on single lines, at which an official is not on duty for trains working, are termed interloops. At these places on branch lines, no special provision, as regards signalling, is made and the security of the points is placed on the padlocking of the tumbler point levers. This has been found satisfactory, considering the infrequent train service and the slow speeds which obtain. As the tumbler point levers are painted a distinctive colour and can be clearly seen by the driver of an approaching train, he has no difficulty in determining whether the points are in the correct position. On the main and more important branch lines, where there is a fast train service, two-way point indicators are provided at the facing points of interloops, the general arrangements being shown in fig. 15. These indicators are operated from the points, each indication being given by means of a miniature arm, extending from a disc, the higher arm reading for the main line and the lower arm for the loop. A sketch of the indicator and working connections is given in fig. 16. With the first movement of the point lever the locking bar is raised and the indicator, which was previously at an upward angle of 45 degrees, would be turned to a horizontal position. On the completion of the lever movement, providing the points are closed, the indicator corresponding to the new position of the points would be raised, the other remaining horizontal. Each indicator arm is counterbalanced and operated by a rod, the lower end of which engages in a notch cut in the slide of the detector rod. The point lever is key-locked and after being unlocked must be returned to the normal, or main line, position before the key can be removed from the lock. As the trainmen operate the levers when a crossing is being made, this precaution assists in ensuring that the points are in the mainline position after the trains have departed. The warning board, fixed approximately 2 400 ft. in rear of the facing points, serves a useful purpose in that, besides denoting the approach to a crossing place, it also provides protection to a train, the rear of which is 600 ft. within the board. Although not ideal as a protective measure this arrangement is necessary, as considerable delays would arise during the crossing of trains if the guards had to afford protection by hand. In addition to the token for the section ahead, a warning advice is handed to the driver, a copy being given to the guard, setting out particulars of the preceding or opposing trains, so that on approaching a crossing place the driver may take the necessary precautions. Consideration has been given to the provision of automatic signalling, to give more definite protection to trains, but its cost is prohibitive.

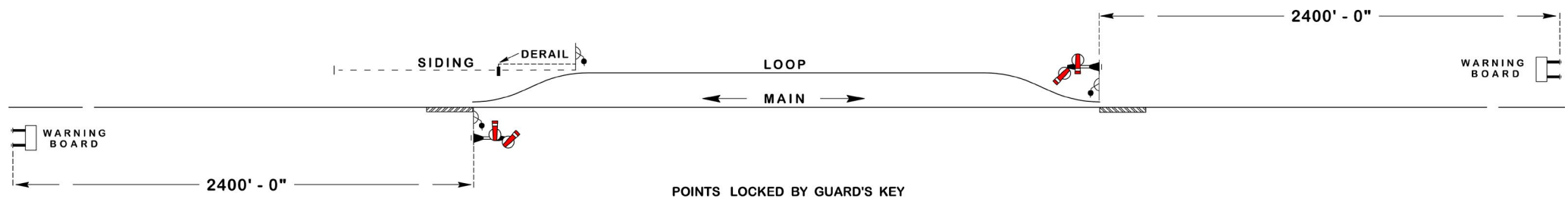


Fig. 15. Arrangement of interloop signalling on the main and the more important branch lines.

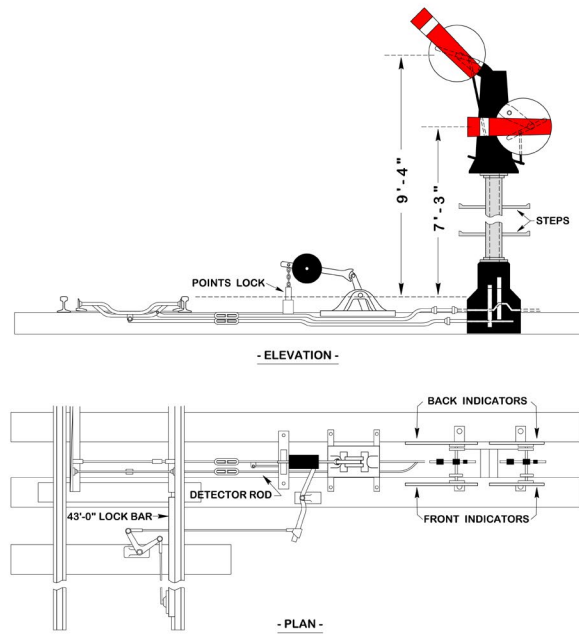
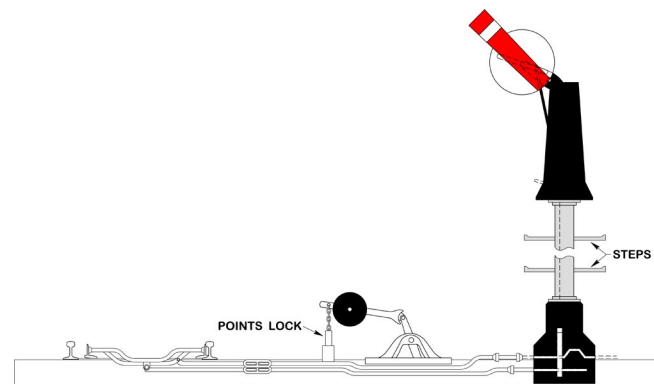


Fig. 16. Points indicators used for the interloop working shown in Fig. 15.

Sidings in Section.

Where a siding is provided in a main line section, similar arrangements to that of an interloop are provided, except that there is only one indicator, for the main line. These “intersidings”, as they are termed, are only agreed to under exceptional circumstances and may be either of the dead end or loop formation. No crossing may take place at one, and wherever possible the points are released by the tablet or staff for the section.



One-way points indicator for an intersiding.

Attended Crossing Stations.

At the stations on those lines where the train service is infrequent but the local conditions make it necessary to provide signalling. And also at those crossing places (interloops) which may temporarily be opened as telegraph or token stations, the expense of providing full interlocking cannot be justified. A simple arrangement of “detector-locked” signalling, as shown in fig. 17, is therefore provided. This class of signalling fills a useful purpose, and can be regarded as a part of the full interlocking which might become necessary at a later date. On the main lines it is the policy to provide crossing stations which will accommodate trains up to 2 000 ft. in length, which means that the distance between the extreme facing points must be at least 2 500 ft. Generally the station, at which the lever frame is fixed, is situated approximately midway between points, so there is no difficulty in working them or the signals.

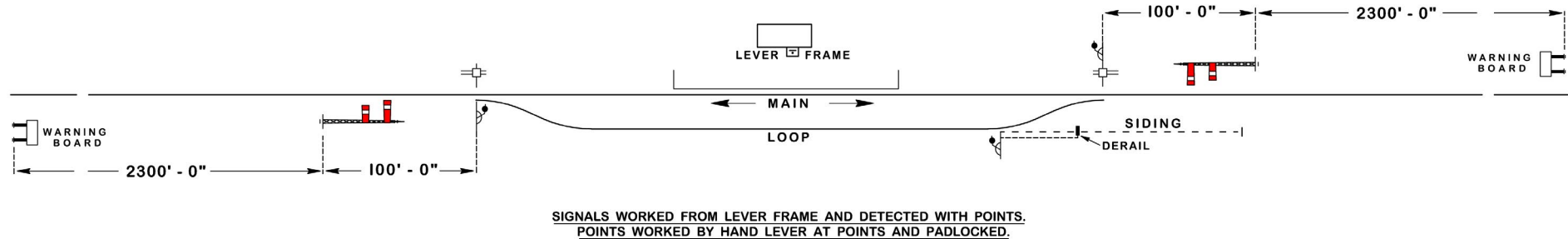


Fig. 17. Simple arrangement of signalling at attended crossing station with infrequent traffic.

The signalling for a main line crossing station is shown in fig. 18 with a junction connection and its signalling shown in dotted lines. The outer signalling, as seen on the left of the diagram, viz : outer home and distant signals, is the usual practice, but where there is a junction, the intermediate home signal and separate distant signal, as seen on the right of the diagram, may be provided. The outer home arm is pointed and functions as a “stop and draw in” signal and where permissive working is in force proves very useful; it also serves to protect a shunting movement made from the station. As the signal shows a red light at danger the question arises whether it is not liable to be confused with an intermediate home, which is an absolute stop signal and fixed approximately 900 ft. from the ordinary home signal. All engines are however, provided with powerful headlights, which enable the signal arms to be clearly seen some distance away, enabling a driver to know the class of signal he is approaching. Experiments were nevertheless conducted with lamps showing an illuminated “vee” and “fishtail” respectively, in addition to the red or yellow light of the signal, but it was found that the white light of the “vee” or “fishtail” merged into the signal light, and could not be clearly distinguished until a driver had arrived near to the signal. These auxiliary lights were therefore not adopted. The interlocking provides for the Outer home lever being released by either of the home signal levers, but the distant signal can only be operated for the main line and is not placed at “all-right” until the token for the section ahead is available. Distant signals and facing point bolt locks are only provided on those sections of the line where fast non-stopping trains are run. Generally the locking bars work with the points, in order to safeguard shunting operations, as it was found that, under these conditions, the lever, if operating both the bolt lock and locking bar, would not get worked. The dwarf signals, as shown in dotted lines, fig. 18, are only provided if the traffic justifies them. Clearance markers, i.e. whitewashed sleepers or rails, laid on the ground between the adjoining lines at about the fouling points, serve to define the limits of the running lines and the regulations provide for a driver bringing his train to a stand within these limits. Similarly, fouling bars are not generally used to check the position of the train, this being provided for by an exchange of hand signals between the trainmen and station official before the road is set for an opposing train, or one is booked to pass the stationary train. Mechanical replacers are provided at outer signals where the configuration of the line prevents the station official from determining when the engine or front portion of the train has passed them.

The regulations require an outer home and for distant signal to be replaced to danger or caution, as the case may be, immediately after the engine of a train has passed it. In single line working, starting signals, as known under double line working, are not used. To safeguard the facing points of a junction or siding connection outside the loop facing points, as shown in dotted lines in fig. 18, route signals are provided. The route signal arm is mounted on a disc which serves to distinguish it from the ordinary signal arms. This signal is only used for single line working; at junctions; or where a single line diverges from a double line, in which case the route signal is fixed on the same post as the double line home or starting signal, but below it; also where a double line merges into a single line. The arm is painted red on the front, with white stripe, the disc being white, and white on the back with black stripe, the disc being black. Where the junction connection is arranged as shown in fig. 18 the two route signals are fixed on the same post, the higher arm applying to the line of least curvature, but in the case of split angle points the two signals are the same height and fixed on separate posts alongside each other. The provision of additional stop signals to protect converging movements at junctions ensures that with the road set for one train, the other train is held at the intermediate home, approximately 1 000 ft. from the fouling point. This affords more definite protection than would be the case if an outer home (stop and drawn in) signal were used.

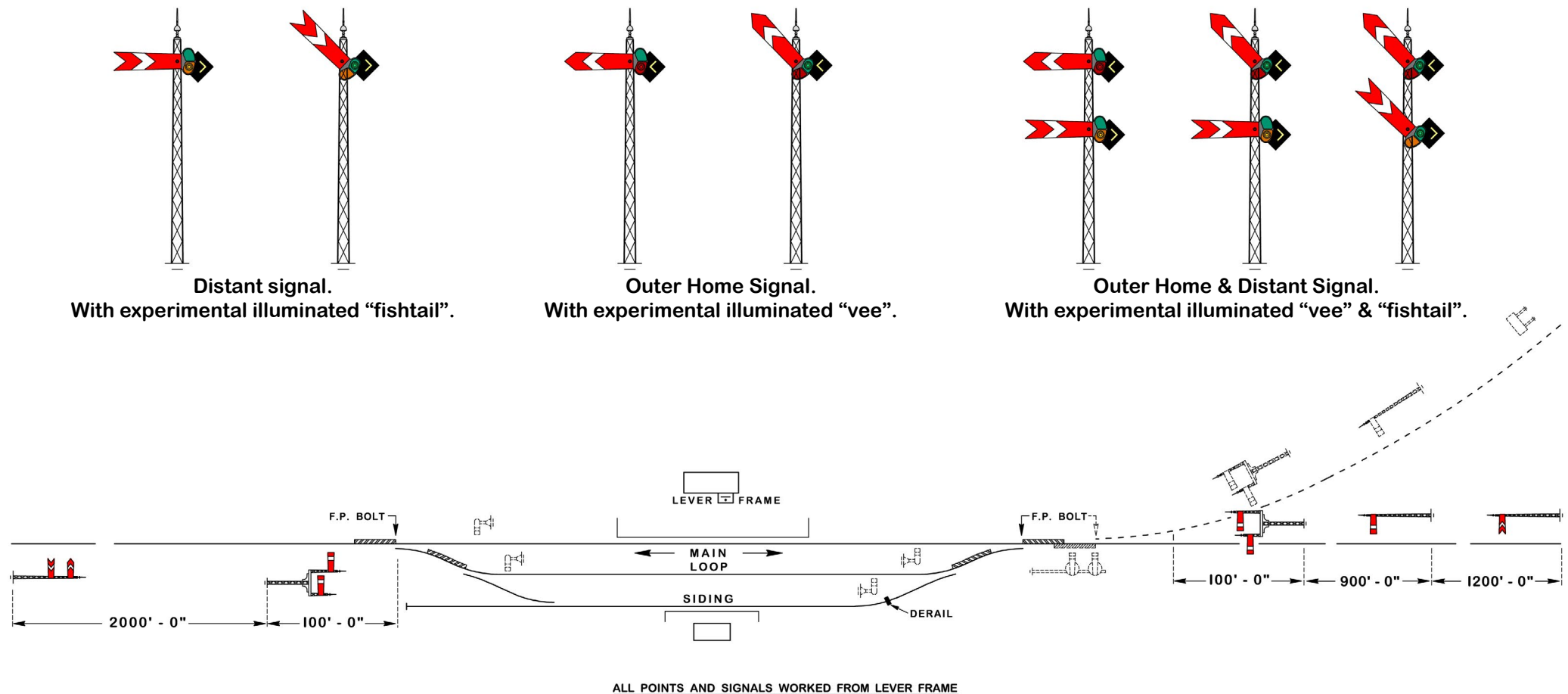


Fig. 18. Signalling for main line crossing station, with junction connection shown in dotted lines.

A large proportion of single line stations have two crossing loops, and in these cases the additional home signals for the second loop are provided, the siding connections being taken off this line. In the general improvements effected by deviations and the regrading of the line the scissors crossing stations in Natal have been uplifted or converted to loop formation. This has not been possible in the case of a station on the Hex River mountain section of the Cape, where the grade is 1 in 40. The station layout and signalling are shown in fig. 19 ; the grade is against the “ down “ direction. It was not possible to arrange the sidings on the straight or on the same side of the main line. In consequence of the curvature of the lines and to facilitate the crossing of trains repeat signals were provided, in order that a driver, after stopping near the end of the siding, would know when to set his train back to the opposite siding so as to be ready to proceed into the next section.

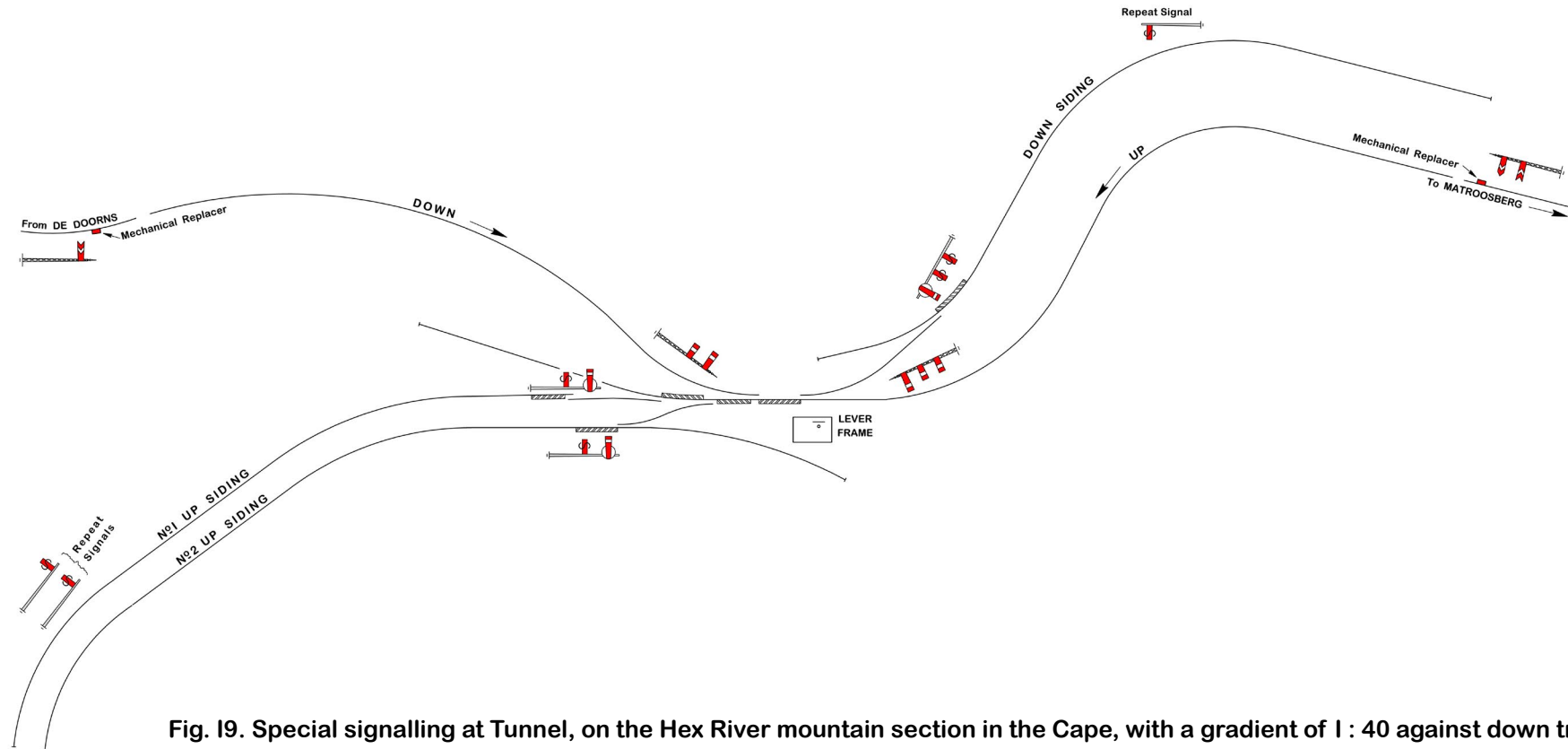


Fig. 19. Special signalling at Tunnel, on the Hex River mountain section in the Cape, with a gradient of 1 : 40 against down trains.

At the larger stations or depots where re-marshalling of trains is carried out, and where a large number of shunting movements have to be controlled, the signal installation is worked from one or more signal boxes. The extent of the yard, distance between the extreme points, and frequency of train movements determine whether one or more boxes should be equipped. The train working instruments are placed in the signal box and when one is employed in a yard on single line, it is fixed approximately midway between the extreme points, one of the yard staff delivering the token to the driver of a train ready to depart, or receiving it from an incoming train, so as to avoid the signalman having to leave the box. Where two or more boxes are necessary, one is placed at each end of the yard, so situated that the receiving of the token from the driver of an incoming train or the handing of the authority to the driver of a departing one is very much facilitated.

A system of control with bell signalling is arranged between boxes. This provides for the lever working the home signal being released by a control lever in the box at the other end of the yard and, when the home signal lever is reversed, the control lever is back-locked. In this way the road is held for the incoming train. This method of control was originally operated by mechanical means, double wire or rod connections being used, but it was felt that much depended upon the signalmen carrying out instructions regarding the working of the levers, and satisfying themselves that the line, to which the train had to be admitted, was clear throughout. It is now therefore the standard practice to provide electrical controls between the levers and track circuits on the running or through lines. The track circuits are direct current, Operating 9 ohm neutral relays and the lever locks operate at 12 volts D.C. Power is obtained from secondary batteries, trickle charged through all-metal rectifiers from a 220 volts, 50 cycle power supply. The circuit wires between the signal boxes may be either 1 064 insulated cables run on stakes alongside the track, or No. 18 gauge copper wires run on the telegraph route. In the majority of cases pull-over lever frames are used at the single line stations and fig. 20 shows the general arrangement of the electric locks, indicators and bell instruments.

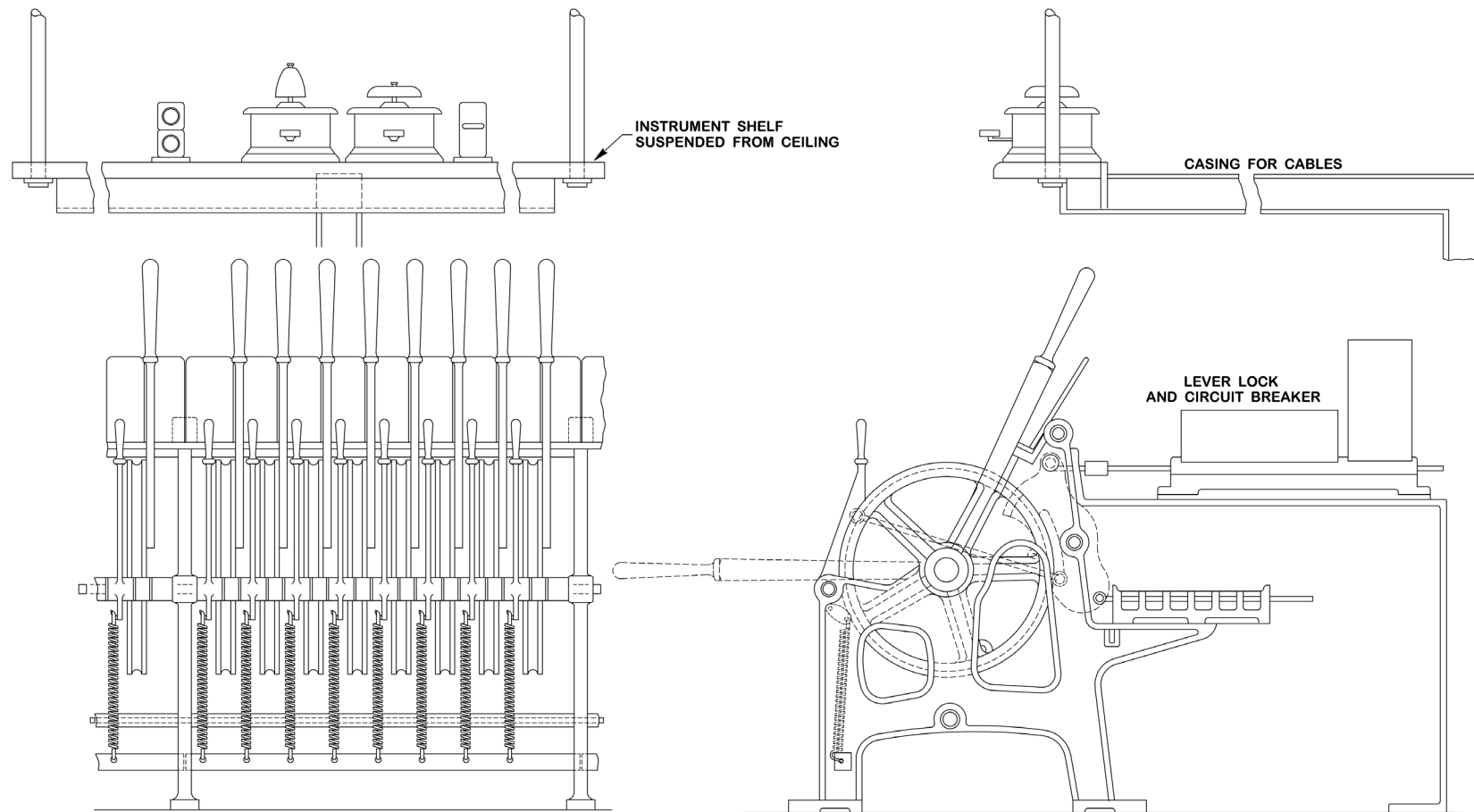


Fig. 20. Pull-over type frame, showing fixing of electric locks and mounting of bells and indicators

Double Line Stations.

The layout of double line stations follows the usual practice of providing trailing crossover roads between the main lines and siding facilities. At a number of these stations loop lines are provided and the platform accommodation is then arranged on them. Fig. 21 shows a diagram of the signalling at such a station, although this may vary according to local conditions.

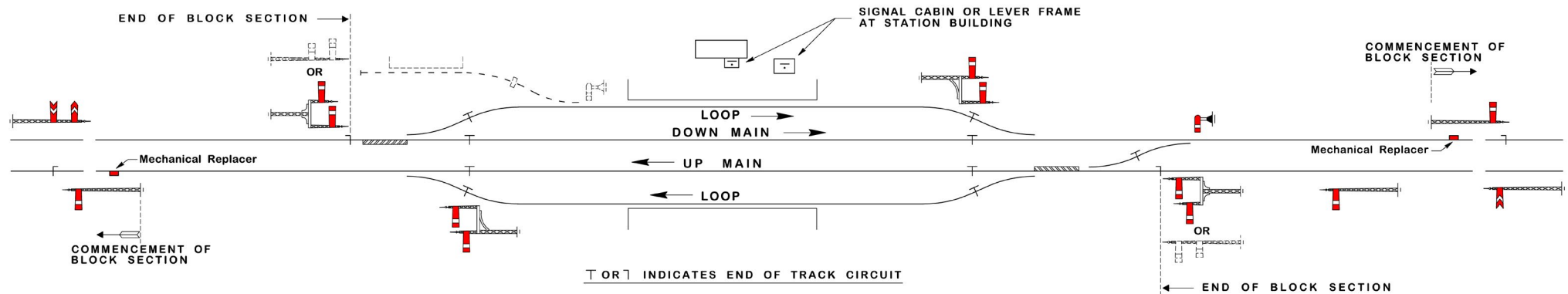


Fig. 21. Typical double line station with platform loops.

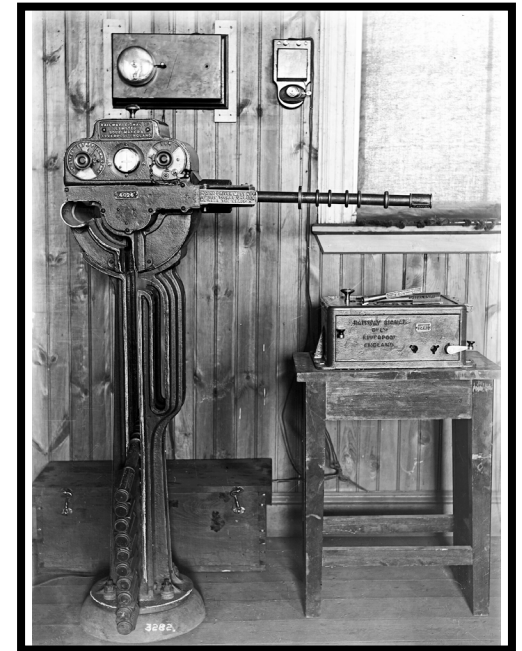
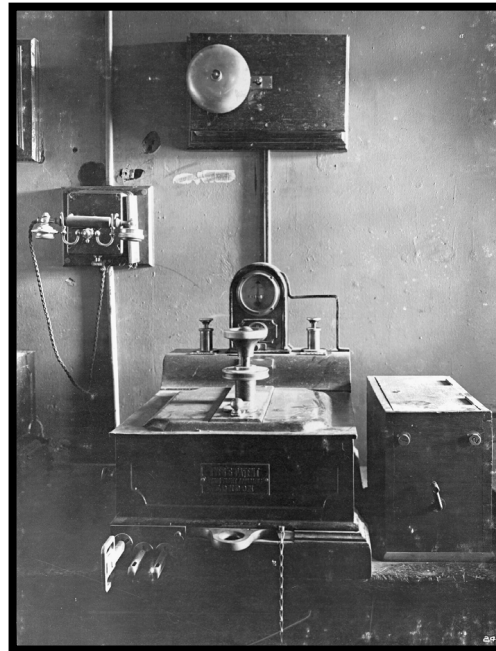
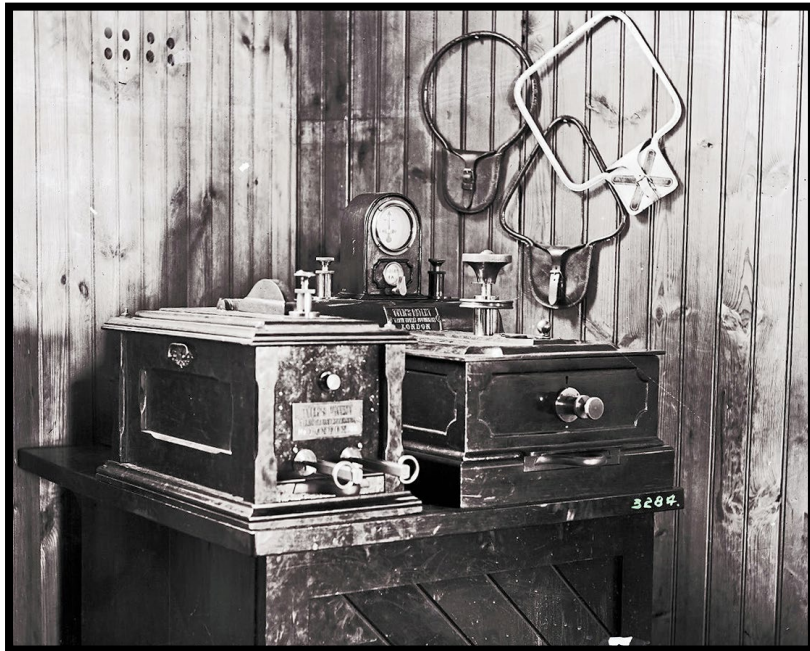
Double Line "Block" Working.

Tyer's three-position needle block instruments were adopted as the standard for double line working and were fixed on a shelf above the levels, similar to the instruments shown in fig. 20. In the early stages after Union these instruments were working as a plain block telegraph, but steps were in due course taken to provide the necessary locking between the outdoor signalling and the block instruments. The various stages of development were passed through, in that the starting signal lever was controlled by the "line clear" position of the needle, the commutator being locked until the train had reached the end of the section, as defined by the signals at the station in advance, and the signal levers at that station had been restored to the normal position. This method necessitated the locking of all trailing points at the stations through the block instruments. Where facing points existed, the circuits became complicated and a simpler system was therefore designed. An additional stop signal, intermediate home or outer home, was provided, giving two stop signals in the rear of the first set of points. A short length of track circuit was arranged immediately ahead of the home signal, the terminating point of the block section. A mechanical replacer was provided on the section signal - starting or advanced starting - and as soon as a train entered the section this would return to danger. Its lever, when placed to its normal position, would become locked until the train had passed the clearing track circuit at the station in advance, the intermediate home and home signal levers had been restored to normal and "line clear" again obtained. The station yard between the home and advance starting signals was, in most cases, under visual observation of the Signaller, but to check the movements, backstroke or sequential locking was provided to compel the signals to be operated in rotation. This met the position, up to a point, but when shunting operations involved the splitting of a train, the locking could be released without the line being clear and very close supervision was necessary to ensure that the instructions, devised to meet this position, were strictly carried out. It was felt, however, that further improvements were necessary and it was decided that the running lines between signals should be track circuited, the spacing of the track circuits being similar to what is shown in fig. 21. with the levers working the signals being locked accordingly. The position therefore is that a signal is held locked by the track circuit immediately ahead and to the next signal, as well as by the track circuit in advance of that signal.

Thus there must be two clear track circuited sections between signals before the signal can be operated, and a train is therefore protected by two stop signals whilst passing through the station. The last track circuit terminates 300 ft. ahead of the advanced starting signal. This method of applying the two-stop signalling principle in double line working was adopted on the Cape suburban lines, Cape Town to Wynberg, and Cape Town to Bellville, and was the means of increasing their capacity under mechanical signalling from twelve to sixteen trains per hour in each direction.

Train Working on Single Lines.

Although the electric train staff instruments have remained in use on the main lines in the Natal province and are also in use in the Transvaal on the connecting line to Natal, the remaining main single lines in the Transvaal, the Orange Free State and the Cape are controlled by the No. 5 tablet instruments. The miniature type staff instruments are also used, but generally speaking tablet instruments have been regarded as standard. They provide for absolute and permissive working and for inter-working, viz. trains crossing at an interloop (unattended crossing place). Three systems for inter-working are in use, subsidiary instruments working in conjunction with the main tablet instruments providing for the crossing of three trains in each direction at the interloop. A pouch with a circular hoop is used for carrying an absolute token; a pouch with a triangular shaped handle for a permissive token; and a pouch with a square shaped handle for an intertoken. The latter (inter-working) pouch is built to carry the two crossing permits and the crossing tablet. The picking up of the token by the driver or fireman has been the subject of much consideration, particularly in the case of non-stopping trains. In the early days when the speed of a train passing through the station would not be more than twenty miles per hour, there was little difficulty, but at the present time, when the speed may reach 45 miles per hour, it is necessary to provide a hoop or handle to the pouch, less likely to cause injury than in the case of the iron hoop or handle, and also to improve the method of handing up the tablet.



Tyer's Electric Tablet and Electric Train Staff instruments that are in use.

After experimenting with light weight material, it was decided that a hoop or handle of cane, encased in leather, was the most suitable and even this may, as the result of more recent investigations, be replaced by rein-forced rubber. To improve the handing up of the tablet, particularly at stations without a raised platform, a so-called “pulpit,” the floor level being approximately 2 ft. 6 in. above rail level, was erected at a suitable distance from the track, from which the station official could, with safety, hold up the tablet pouch at such an elevation that the engineman, standing erect, would have little difficulty in picking it up. It should be mentioned that the engineman, before picking up a tablet, throws the pouch containing the one for the section in rear on the ground near the pulpit. With the inter-working the drivers of the opposing trains exchange the permits and tablets, so that they will be returned to the station from which they were issued. If three trains have to run in succession in the one direction, the first and second each carry a permit and the third the crossing tablet. With only one train the two permits as well as crossing tablet are carried by it.

Non-Token Working.

Although the absolute-permissive (A.P.B.) system of automatic signalling has not been put into use on the South African Railways, schemes have been prepared for so doing and fully considered. Such work on a large scale could not be justified. However, nevertheless work is in hand on a modification of that system on two sections, under which intermediate automatic signals are to be installed. Consideration has also been given to using centralised traffic control (C.T.C.) over a section approximately 50 miles long, but the heavy capital and maintenance costs and the necessity of retaining the staff at the different stations led to the scheme not receiving approval. It has been possible, however, to establish non-token working over certain absolute sections of single line as a part of remodelling work or where, owing to the frequent train service, the exchange of tokens would cause delays. In this class of working block bells are provided between each signal box and a code set up by which the train arrangements are made. A release or direction lever is provided in each box, controlled by a normal and reverse lock. The levers working the route signal giving entrance to the non-token section are electrically locked in the normal position. Where colour light or power operated signals are used, the signals themselves are also controlled. “Locked” or “free” indicators are provided behind the controlled levers. Track indicators are used unless an illuminated diagram is arranged to show the track circuited section of line over which non-token working is in force. Where mechanically worked route signals are used, replacers are provided to ensure they return to danger after being passed by the engine. Five line wires are provided between the signal boxes, two for track repeaters, one for the control of the release levers at each end of the section, one for the release of the signal levers and the remaining one for common return. The track circuits are direct current with 9 ohm neutral relays, unless where electric traction is in use, it is necessary to install A.C. track circuits, in which case they are condenser fed. Before the release can be given for a train movement, the locks and signals affecting an opposing movement are proved in the normal position and the track circuits throughout the section are clear. The release lever in its reverse position is held locked by all opposing movements, and also while the train is occupying the track circuits. A stick relay is provided in the lock and signal circuits to ensure that the release lever, once reversed, must be restored to normal and again worked, should the release be required for a following train. Two-way foot plungers are used to guard against an error being made, and the levers at both signal boxes being reversed simultaneously. Even if this were to occur the signal levers would not be released, but inconvenience and delay would be caused by each release lever being held locked reversed until the maintainer could attend and restore them to normal.

Electrification and Electrical Signalling.

The heavy increase in the traffic from the port of Durban put a severe strain on the Natal Railways, and it became evident that additional facilities for handling it would have to be provided. The main route to the Transvaal was through difficult country, rising from sea level to an altitude of 5 400 ft., and grades of 1 in 30 with curves of 300 ft. radius were common. Under such adverse conditions traction was a very serious problem and it was decided, after much deliberation, to adopt

electrified working over the busiest section of the main line. It was decided to use direct current at 3 000 volts, supplied to electric engine units through overhead equipment. The first portion of the electrification programme was introduced in 1926 and covered a route mileage of 171. Extensions of 29 and 44 miles were opened in 1931 and 1934 and the final section of 77 miles to the Transvaal border was completed in 1937, making a total of 321 route miles of main line working from Durban to Volksrust, apart from other connecting lines also electrified. Concurrently with electrification, deviations and doubling of the single line were carried out on certain sections and at the present time of the 321 route miles, 102 are double track. During the various stages of the construction work, complete remodelling of the signalling was carried out to suit double line conditions. Traffic requirements did not call for a departure from standard double line block working with mechanical signalling, although some difficulty was experienced in locating the semaphore signals to avoid interference from the traction structures. Electrification in Natal provided for heavier train loads being hauled at a more uniform speed, thus increasing the capacity of the line. The position was somewhat different on the Cape suburban lines, where the required increased capacity could only be met by additional trains with faster timings. To obtain this it was decided to electrify on the overhead 1 500 volt D.C. system.

Although electric traction on the suburban lines would speed up the working and enable additional trains to be run, it would not meet the complete demands, as the block sections under mechanical signalling only allowed for 16 trains per hour in each direction. It was doubtful if more than two additional trains could have been worked. Additional block sections were therefore necessary, to enable the time interval between trains to be reduced. Having regard to the capital cost of installation and annual operating costs, it was decided to replace the mechanical signalling on the 8 miles between Cape Town and Wynberg by semiautomatic and automatic signalling, the semi-automatic signals being controlled from the existing mechanical lever frames, and put in a power installation at Cape Town. Up to that time, there had been only three cases where automatic signals had been used. One was on single, the other two on double line sections, with 10 volt battery operated semaphore signals and D.C. working throughout. The single line signalling was only in use a comparatively short time, as traffic soon necessitated the line being doubled but the double line automatic signalling was in use in one case for 20, in the other for about 10 years. The latter installation, in the Cape Town area, was abolished when the general scheme of electrical signalling was introduced. The Cape suburban routes comprise the line to Simonstown, 23 miles from Cape Town, the first portion of the main trunk lines to the North. The residential area terminates 12 miles out at Bellville. The Simonstown and Bellville double lines run alongside each other for 2 ½ miles to Salt River, and junction connections between them are provided. The residential traffic on the Simonstown line commences to thin out at Wynberg, where approximately 40 per cent of the trains terminate, and it was therefore decided that the electrical signalling should only be provided to this point. With the electrification of the line to Bellville, electrical signalling was installed on it also, the work including a power installation at Salt River, replacing the old hydraulic plant.

The all-electric power system was selected for Cape Town, although consideration was also given to using the electro-pneumatic system. The frame has 143 levers (125 working) and mechanical interlocking with indication locking on point levers. The installation was brought into use early in 1928 and controls all movements into the 14 terminal platform lines. The suburban services commence about 3.30 a.m. and finish at about 12.0 midnight. When the new signalling was introduced, steam working was in use and approximately 450 trains worked into or out of the station between those hours, whilst in addition 600 engine movements from and to the engine roads were dealt with. Electric traction, introduced in 1928, of course reduced the number of engine movements. More recent figures show that between 3.30 am and 12 midnight, 250 steam trains and 300 electric trains were being worked into or out of the terminus. The Salt River installation, brought into use at the end of 1932 comprised 71 levers, (50 working) and is similar to the Cape Town one, except that it has electric interlocking. The signals are 3-aspect long range colour light signals, With Red, Yellow and Green aspects, for main or running lines, with 2-aspect, Red and Yellow short range signals controlling the departure from loop or siding lines to the main lines.

At the initial stations of the colour light area, a 2-aspect, yellow and green, long range signal is used as the outer signal from the manually controlled block section, the Yellow aspect being normally displayed, and the Green controlled by the signal and track circuits ahead, in accordance with usual practice. The signalling on the Wynberg line was based on a train interval of 105 seconds, which in actual practice worked out for non-stopping trains at 90 seconds, while on the Bellville line, where goods trains had to be considered, the headway between the slowest trains was 2 ½ minutes. All signals have the absolute overlap control, with the exception of those located at the immediate entrance to the station, where owing to the distance between these signals and those at the departure end, full block overlaps had to be arranged. Generally the overlap, or full block section, on the Wynberg line is 600 ft. and on the Belville line 900 ft. Each aspect of a long range signal is provided with two moulded Fresnel lenses, the front one being of clear glass, 8 ⅜ in. dia. and the inner lens, 5 ½ in. dia. coloured. The lamps are double filament, rated at 6 volts 24 watts. Short range signals have single 6 ⅜ in. dia. lenses of the required colour. The lamps used are 110 volts 40 watts. The multiple unit signals have side lights to assist the driver in determining the indication displayed should he be standing near to the signal. Route indicators of the projector type and of the stencilled number or letter type are used, the latter for short range work such as starting signals from the terminus. Position light shunt signals are used at Cape Town and Salt River, the "caution" signal being displayed at an angle of 45 degrees, and are very satisfactory, particularly at Cape Town terminus, where the lines are used in both directions, as they remove any confusion which might have been caused by a colour light shunt signal showing danger, and having to be passed by a train entering on the line to which the shunt signal applies. This difficulty could have been overcome by operating the shunt signal, but that practice was not favoured, and the position light signal was therefore adopted. Point machines at Cape Town and Salt River are of the switch and lock type, operated at 110 volts D.C. from a battery of 54 cells, 75 ampere-hours, on floating charge, with duplicate rectifiers, power being obtained from 2 200/110v transformers.

At Cape Town the transformers, rectifiers and batteries are in a building adjacent to the signal box; at Salt River they are under the box. Track circuits are condenser fed, the majority being double rail with resonated impedance bonds, but single rail track circuits are used in station yards or where the traction return is facilitated by reason of the adjoining rails being electrified. The train shunt of the impedance bond track circuits averages 1 ohm, but an average shunt of 5 ohms is obtained with the single rail track circuits in Cape Town yard. The control coils of the track relays normally operate at approximately 4 volts. The signalling power supply is single phase 2,200 volts 50 cycle, available throughout the sections, the signalling line being carried on the overhead traction masts. Pole line transformers 2 200 / 110 volts, are located on the masts to suit signalling requirements. The signalling line is broken at different places and switches, operated from the respective signal boxes, are provided to enable any one or more sections on which a failure has occurred to be isolated and, if necessary, power supply to be obtained from another sub-station or main station. The re-signalling of the Cape Suburban lines enabled a number of the signal boxes to be closed for a portion of the 24 hours, a box being now only opened when shunting operations have to be conducted. For this purpose a "king" or "switching-out," lever is used which, in addition to locking the other levers in their respective positions, also controls the exhibition of "A" lights at the signals, used to show when they are working automatically. Bell instruments are generally used for signalling trains forward and are switched through by reversing the switching-out lever. Train describing instruments have, however, been provided on two adjoining sections where difficulty was experienced in correctly routing the trains. They provide for nine descriptions and a cancel indication, the first, second and third descriptions being displayed on the receiving instruments. Transmitting and receiving instruments were provided at the two end signal boxes while the centre one, which is switched out for the greater portion of the 24 hours, is equipped with retransmitting instruments. The descriptions, having been set up, are automatically sent forward by the passage of the train over the track circuits and also automatically re-transmitted at the center signal box, should it be switched out. The descriptions are automatically cleared off the receiving instruments when the train, having occupied the selected track circuits, has proceeded on its journey or been shunted clear of the track circuits. The results of the working of the all-electric signalling proved both the economic value and the reliability of it, so that when extensive track alterations were contemplated at Johannesburg, it was decided not to enlarge the two mechanical plants but install an all-electric one instead.

Johannesburg is regarded as a semi-terminal station. All trains from the Coast, Rhodesia, and the North and Eastern Transvaal terminate there. It is practically the centre of the reef area, being 28 miles from Randfontein on the west and 30 miles from Springs on the east, between which two points a heavy suburban service is worked. Two up and two down lines on each side of Johannesburg split up into seven through passenger platform lines and one through siding line, each of which is of sufficient length to accommodate two suburban trains. The all-electric 129 lever frame was brought into use in 1931, with electric interlocking but no indication locking. Mechanical signalling being in use at the stations on each side of Johannesburg, 2-aspect colour light signals, showing Red and Green, were provided, long range for the running lines and short range as platform intermediate signals. These signals, the position light signals, route indicators and D.C. point machines were similar to those in use at Cape Town. Owing to the presence of leakage currents from outside sources, A.C. track circuits were used, each reactance fed through a step down transformer of 110 / 12 volts, the secondary being provided with tapings from 1 to 12. The reactance was adjustable from 1 to 25 ohms at 50 cycles and a very large range was obtained by combining the taps on the transformer with those of the reactance. The track relays were normally rated at 1 volt on the track winding and an average of 5 ohms train shunt was obtained. During the summer months, severe and sudden thunderstorms occur, often with a ½ in. rainfall within a few minutes, but it was not often that the track feeds had to be altered although the ballast resistance had dropped very considerably. The reactance feeds were changed to condenser feeds on the introduction of electric trains in the Reef area in 1937 on the 3 000 volt D.C. system. The local trains have motor coaches, as in the Cape suburban working, electric locoable remodelling of station yards, deviations of track, elimination of level crossings, and re-signalling. Colour light 3-aspect signalling was then put in throughout the 58 miles from Randfontein to Springs, providing for a 2 ½ min. headway between trains in the Johannesburg, or central, area for a distance of 13 miles. This section of line, Langlaagte to Germiston, consists of quadruple and quintuple track, and deals with the heaviest service of trains. West of Langlaagte and east of Germiston traffic is not so intensive and a 3-minute headway was provided for. The general arrangements were similar to those in use at Cape Town except that route indicators of the “theatre” type were used for the long range indication. Single rail condenser fed track circuits were also employed throughout, track relays being normally rated at 1 volt on the trackside. A diagram of the signalling and general layout of the tracks at a station on quadruple lines is shown in fig. 22.

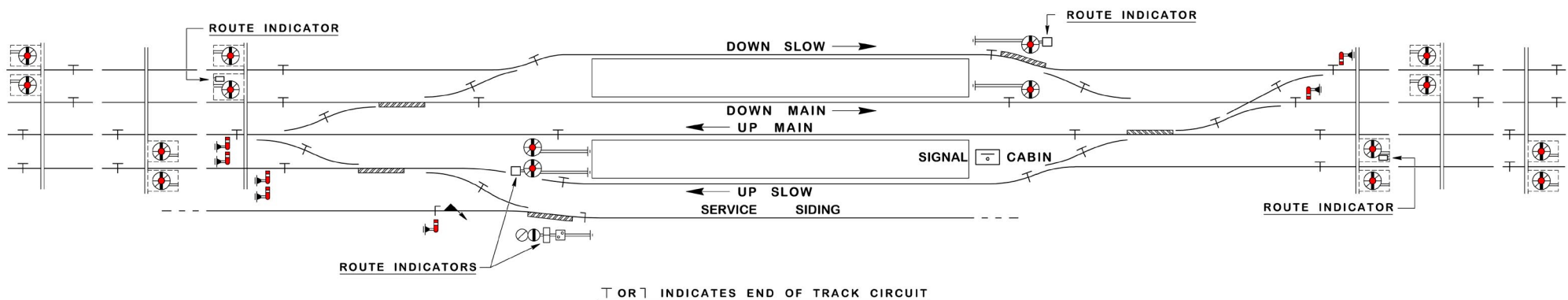


Fig. 22. Signalling and track layout at a station in the Reef area.

The old mechanical lever frames were adapted for the control of the colour light signals, but at Langlaagte an all-electric installation was provided. A marshalling yard had been laid out and additional junction connections provided, the extreme points being at too great a distance to permit of mechanical operation from one signal box. The new frame of 79 levers (51 working) had electric interlocking and indication locking on point levers. In previous such installations, secondary batteries, on floating charge, provided power for the point machines, but at Langlaagte the 32 machines were fed direct from duplicate metal rectifiers, each of a capacity of 5 K.V.A. Although the points are frequently used, little or no trouble has been experienced. Power for signalling purposes is obtained from a 6 600 volt three-phase supply, which is available throughout the electrified area, and provides current for lighting the stations. Electric traction was operating in the Reef area for some little time before the colour light signalling was completed. In April 1938, while a changeover was taking place, a leakage of the 3 000 volt traction current started a fire at the Johannesburg signal box after a heavy rainstorm. It was caused by the catenary carrying the contact wire coming in contact with the underside of a signal gantry during the passage of a train with four motor coaches. The cables to the signals on the gantry were in piping, but owing to the traction earthing system breaking down the 3 000 volt current which had "charged" the gantry, caused the pipes to fuse and the current was taken up by the signal cables to the relay cabinets in the signal cabin. Unfortunately a short period elapsed before the breakers at the substation tripped, as the pantographs of the motor coaches, although fouling the overhead equipment, did not bring it to earth immediately, this period was sufficient to prevent the fire from being got under control, and practically the whole of the signal box equipment was destroyed, or severely damaged. Complete dislocation of traffic resulted and trains had to be signalled forward by hand.

Steps were immediately taken to restore some signalling for through working and essential shunting movements by using a 47 lever all-electric frame, imported for an installation at another station. All levers were made use of, and this temporary expedient was placed in service in the short space of 11 days; this was very satisfactory, seeing that another box had to be erected near to the old, new plans and circuit diagrams prepared, the frame electrically interlocked and all relay equipment installed. The frame comprised 32 levers controlling signals and route indicators and 15 levers working points (19 machines); there were 48 track circuits to be connected up. It remained in use until the end of 1939, when it was replaced by relay interlocking. The installation of relay interlocking followed as the result of inspections on the English and Continental Railways, and the very valuable discussions, which the author (S. Starkey) had in 1937 with the signalling officers. He formed the opinion that relay interlocking is very suitable for these stations dealing principally with passenger or through traffic and where only a limited amount of shunting takes place. In order to gain experience with relay interlocking, the administration decided to install it at Johannesburg, where a new lever frame was required, and at two other stations on the Reef area where it had previously been agreed to provide power installations, using a different type at each place. The "entrance-exit" system was installed at Johannesburg, as seen in fig. 23, and provided for 206 routes. The operating panel controls 58 point machines, 40 running signals and route indicators, and 33 shunt signals. The area included in the control extends over approximately 1 ½ miles, and there are 68 track circuits in it. Another route relay equipment, for 40 routes, shown in fig. 24 was installed at Jeppe, and comprised 40 routes. The panel controls 17 point machines, 22 running signals and route indicators, and 11 shunt signals. The area controlled extends over 2 miles, in which there are 35 track circuits. The remaining route relay installation, seen in fig. 25, was provided at Krugersdorp and controlled 41 routes. There are 21 point machines, 20 running signals and route indicators, 8 shunt signals and 36 track circuits. The control area extends over 2 ½ miles.

The route relay system is well known and there is no necessity to attempt a description, but it may be mentioned that the working has been highly satisfactory, and the experience gained will no doubt be of great value to the railway administration. In support of this it may be mentioned that approximately 500 passenger and goods trains per day are dealt with at Johannesburg, and during the peak periods considerable advantage has been gained by the saving of time in setting up the routes. It is of interest to record that the Christmas traffic in 1939 was heavier than in any previous year, and was dealt with without any delay. According to operating officials, this would not have been possible with individual working. Five all-electric installations are in course of being provided in connection with remodelling work.

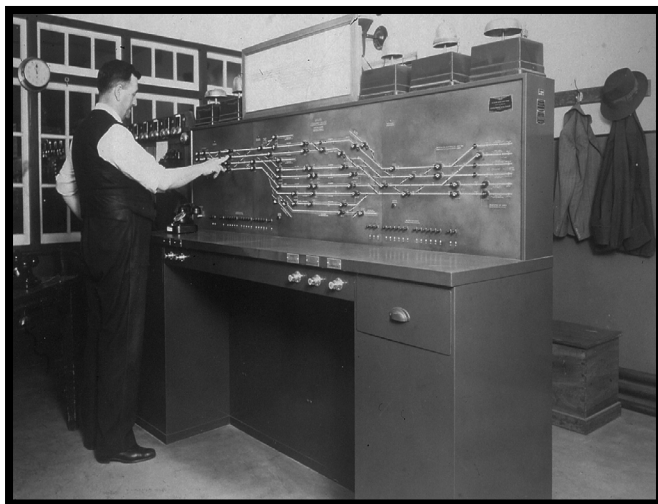


Fig. 23
"Entrance-Exit" type relay interlocking panel
at Johannesburg.

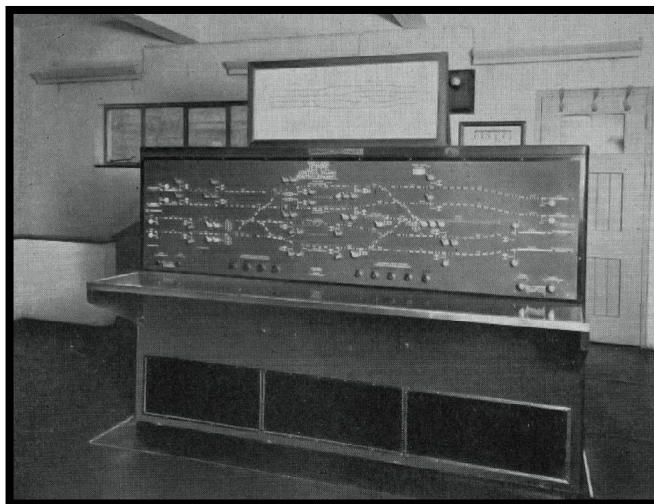


Fig. 24
Relay interlocking panel
at Jeppe.

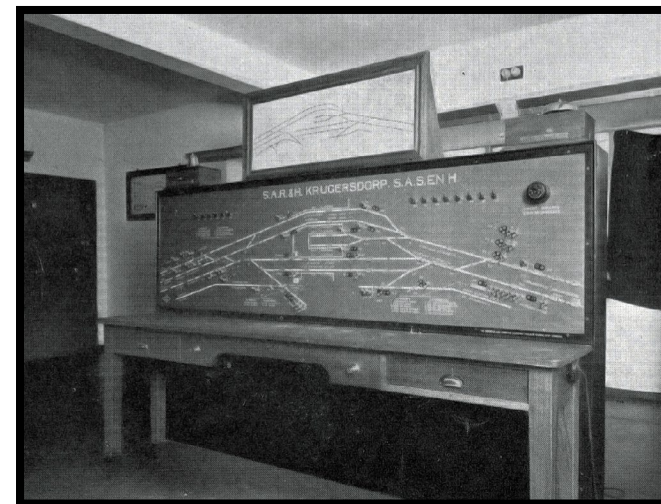


Fig. 25
Relay interlocking panel
at Krugersdorp

Installations of 3-aspect colour light signalling are also in use on the first portion of double line, for about 5 miles, outside Durban and on a 4 mile section of double line from East London. The electric signalling near Durban was put in to deal with the intensive train service in the peak hours and a 2 minute headway is provided for. At East London it was provided to enable absolute working, with a train time interval of 5 minutes, to replace the permissive block sections of 7 ½ minutes. At Durban, where electric traction is in use, condenser fed track circuits were provided, but at East London reactance track circuits were installed, as it was possible to make use of the relays originally fitted at Johannesburg prior to electrification. The signalling generally was similar to what had been carried out in the Johannesburg area. At certain of the larger double line stations where, under mechanical working, two signal boxes would have been required, it has been possible to use electric point machines, and in some cases electrical signalling, to enable one box to do the work. Generally one end of the yard would remain under mechanical working and the points at the other end be worked by power. At these stations A.C. power supply was available, either from a railway or municipal source, and this was transformed down to the standard signalling supply pressure of 110 volts. Duplicate rectifiers are provided for supplying the point machines. This enabled 110 volt D.C. point machines, similar to those of the power installations, to be used and spares kept down to a reasonable limit. Condenser fed track circuits are provided for track locking the points levers. Signal levers working mechanical signals are controlled over the point indication relays and detectors at the points eliminated.

Summary.

It can be accepted that the only interlocked signalling in use prior to the commencement of the South African War in 1899 was that installed by the N.Z.A.S.M. in the Transvaal. Up to the date of Union (1910) signalling work had gradually been carried out, and at that time on the railways, controlled by the three administrations. Interlocked signalling had been provided at 197 stations, the number of lever frames being 206, with a total of 2 696 working levers.

At the end of 1932 there were 564 mechanical locking frames in use, with a total of 10 059 levers in use, and 3 all-electric power frames with 296 working levers.

In September 1941, the mechanical lever frames numbered 720, with 14 045 levers in use and 4 electric power installations, with a total of 270 working levers, these figures being exclusive of the three route relay installations, one of which replaced an all-electric installation comprising 120 working levers, and the other two replaced mechanical lever frames. It might also be of interest to record that very nearly 1 000 colour light signals are in service and approximately 160 position light shunt signals.

Level Crossings.

Having regard to the necessity for keeping down costs during the construction of railways in the development period in South Africa, it will be appreciated that a large number of level crossings had to be arranged. Up to the date of Union, the only protection afforded at the level crossings outside station areas was by means of a sign board, fixed on each side of the railway and showing to the roadway, indicating the presence of a railway crossing. At crossings within station precincts where a signal installation was in use, gates or balanced poles worked from the signal cabin were provided, or if such facility could not be arranged, a crossing keeper was stationed to control the road traffic. Balanced poles or booms were in more general use than gates, and although originally the booms, which were approximately 4 ft. 6.in. above ground, did not effectively close the crossing, as it was possible for a pedestrian to get under the boom. This was remedied by the provision of a collapsible fringe or net, supported from the boom, which filled in the gap to within 6.in. of the roadway. Use was also made of a single bar swing barrier at those crossings, where a crossing keeper was in attendance. The driver or a train approaching such a crossing would sound the engine whistle some distance away. This would be the signal for the crossing keeper to close the crossing, after which he would exhibit a hand signal for the train. With the comparatively slow speeds of trains, the sign boards and hand operated barriers served the purpose, particularly as the railway traversed vast stretches of open country where a clear View of any level crossing was obtained. With the development of the railways after Union, which resulted in the speed of trains being increased, it became essential for improved methods for the protection of level crossings to be arranged. Having this object in view experiments were made with flashing light signals which, being operated by track circuits, would indicate to the road user that a train was approaching. In 1926 a commission was appointed to look into the general question of railway level crossings, with special reference to approximately 230 crossings which had been brought to notice, owing to their being situated on main roads and/or to the location preventing a clear view of the railway or roadway being obtained. Recommendations were made respecting the elimination of certain crossings, and the nature of the protection which was considered suitable at others; these were generally worked to. The standards adopted for the protection of level crossings are as shown in figs. 26 and 27, for single line, but similar protection would apply to double track if booms were not provided. The arrangements shown in fig. 26 would mainly apply to the level crossings on branch lines, or to crossings on main lines in the open country where a good view is obtained of railway and roads. The "HALT" board, on each side of the railway track is preceded by a warning sign in the shape of a cross. The letters "HALT" are indicated by red reflector lenses, the cross being picked out by white reflectors.

On the railway, two Whistle boards are fixed on each side of the roadway, the distant board being at least 1 200 ft. from the crossing. The diagram, fig. 27, shows the protection given at the more important level crossings. Red flashlight signals are provided in addition to the "HALT" boards and distant warning signs. In these cases the letters of the "HALT" boards are picked out by white reflector lenses. The flashlights are suspended from the "HALT" boards and operate alternately at about 70 flashes per minute, being controlled through track circuits. The track circuit on each side of the crossing is of such a length that on the approach of a train a minimum of 20 seconds warning is given, this time being arrived at from the speed of the fastest train operating in the particular locality. All open crossings have cattle guards on each side of the crossing, to prevent animals from straying along the railway line. The standard form of level crossing barrier worked from a signal box consists of two balanced poles of lattice type on each side of the railway track, meeting at the centre of the roadway and rising to an almost vertical position. Rods are suspended from the poles so as to fill in the gap to ground level when the poles are across the roadway. When the poles are raised the rods collapse so as to form the least possible obstruction. Warning signs as shown on fig. 27 are also provided, but the flashlights are controlled through the lock lever, and operate 7 seconds before the barriers commence to lower. They remain flashing while the barriers are across the roadway and until they are raised to a position which would permit vehicles to pass. On the railway, signals and distant whistle boards are provided, and if the crossing is outside station precincts the crossing-keeper would be advised of an approaching train by a bell signal operated from the adjoining station, or by means of a track circuit. Red flashlight signals have been provided at 71 crossings on double lines, and 83 on single lines, but of these 25 have been eliminated by deviations, or the provision of overhead bridges or subways in accordance with the general policy of the administration which has, so far, brought about the elimination of 187 level crossings.

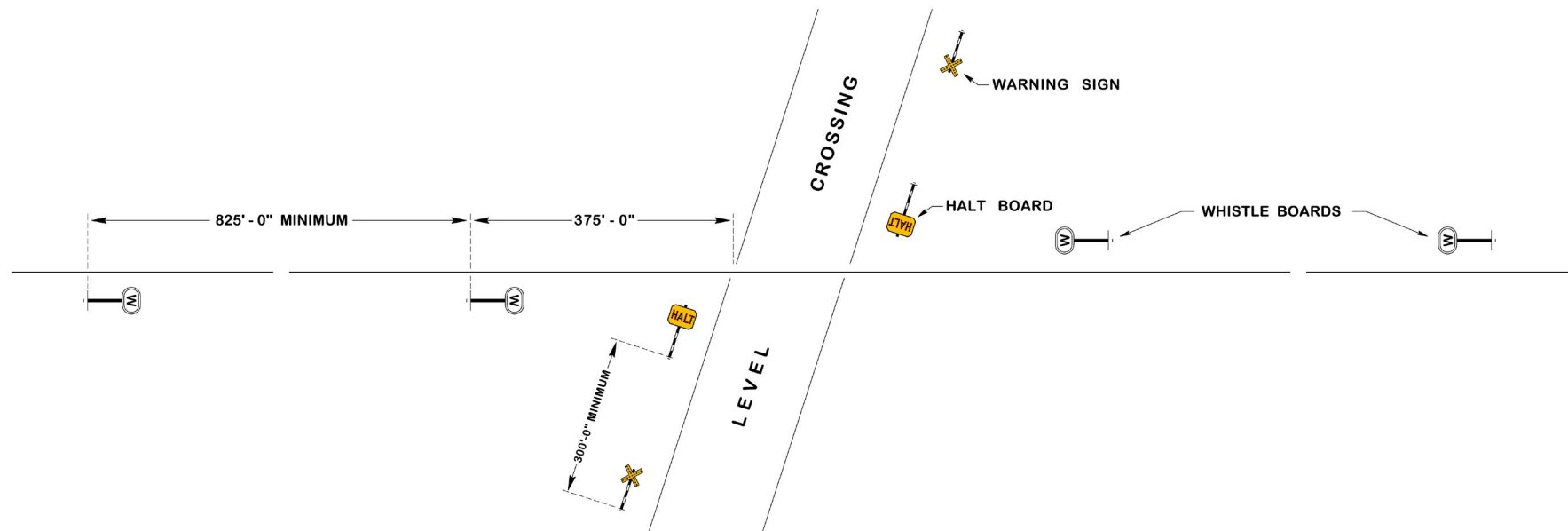


Fig. 26. Level crossing arrangement used on branch lines or main lines in open country.

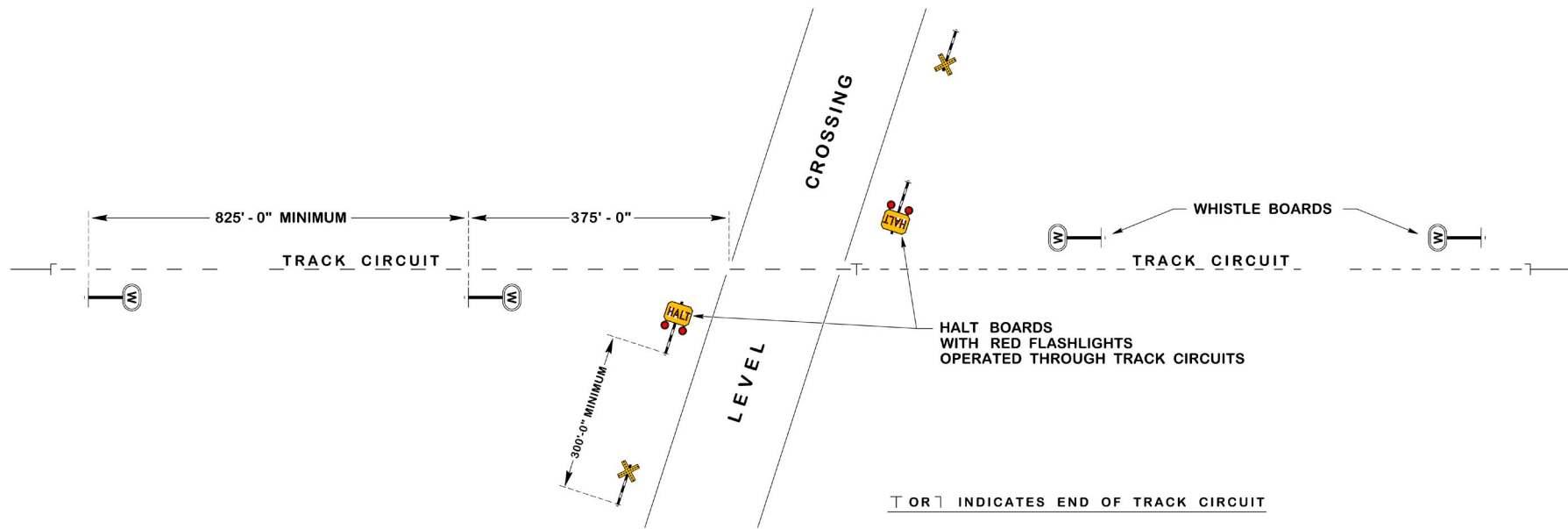


Fig. 27. Level crossing arrangement used at more important crossings.

Conclusion.

In this record of signalling progress on the South African Railways, the author has avoided entering into technical details, as the principles and apparatus used are in accord with general practice. In certain cases, however, the method of applying them has had to be varied to meet conditions of working peculiar to South Africa.

In conclusion the author wishes to record his appreciation of the assistance given to him by the retired and present officers of the railway administration, who were able to supply much information needed to enable this record to be made.

-: Acknowledgments :-

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Transnet Heritage Library.

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Various Signalling pictures on the pages to follow, courtesy of the Transnet Heritage Library.



Intermediate crossing place with Indicators - Set for main line



Intermediate crossing place with Indicators - Set for loop line



East entrance to Johannesburg station.



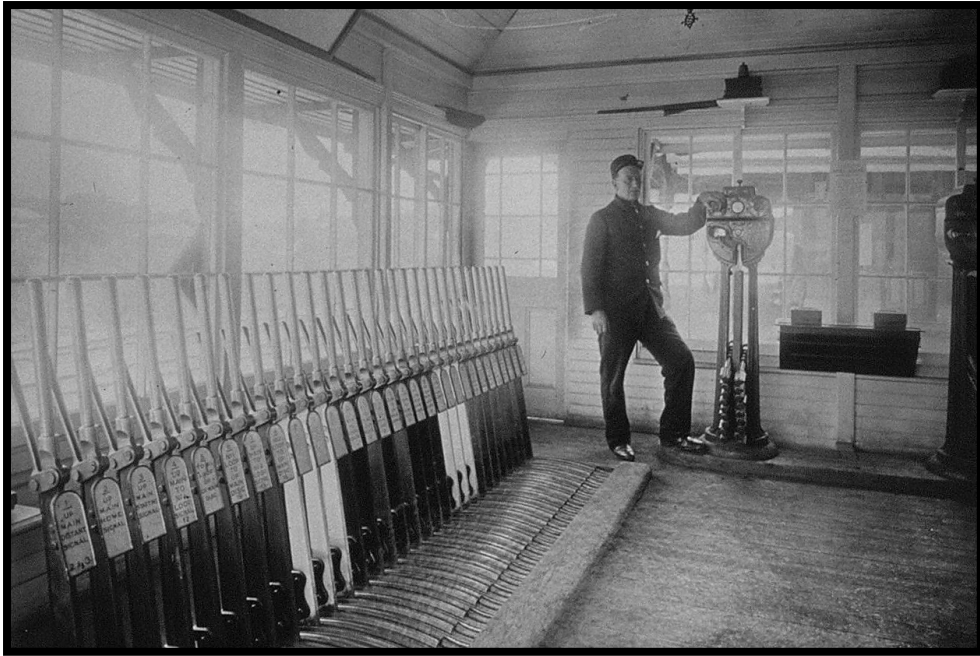
Krokodilpoort station.



Points indicator.



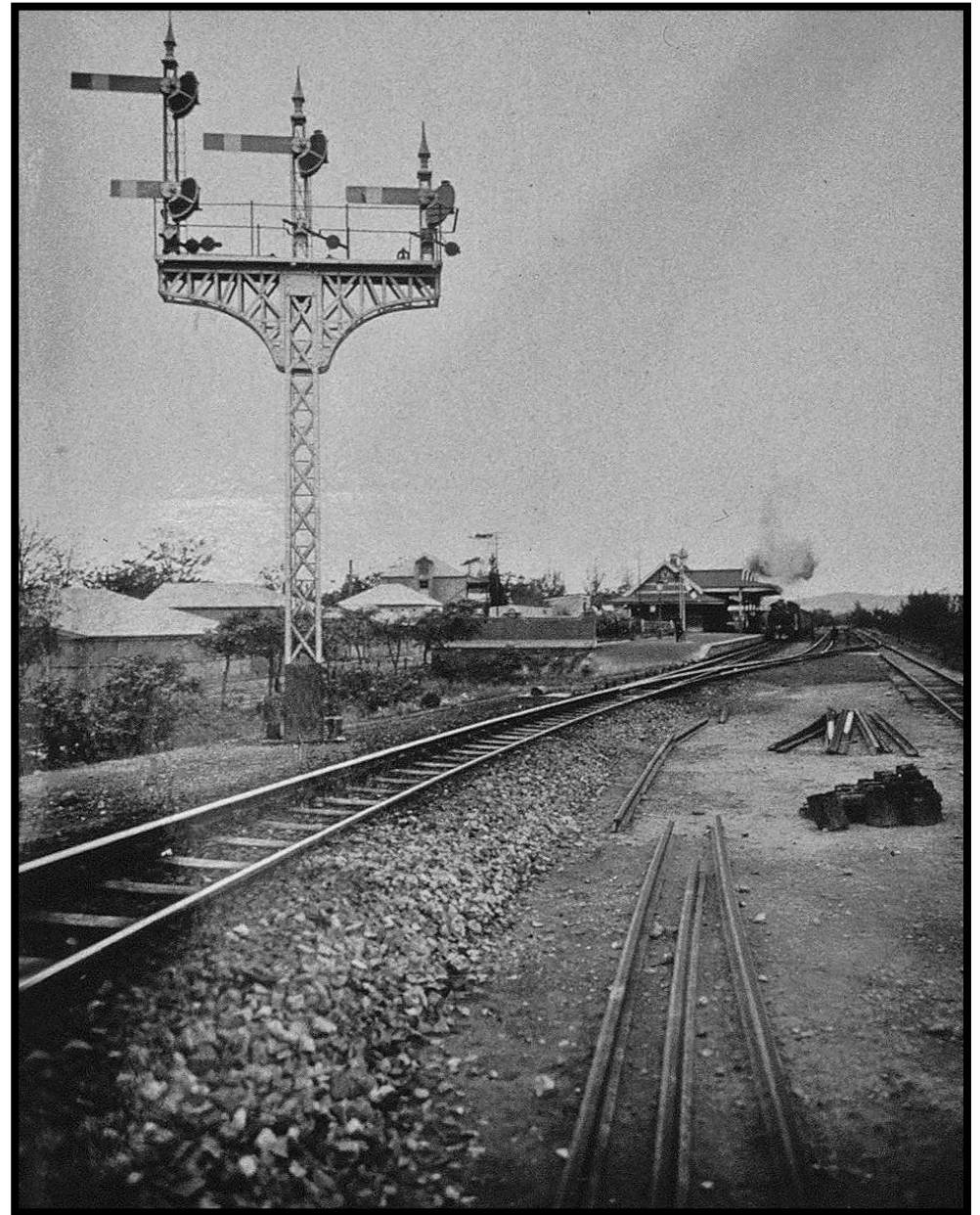
Testing of points indicators with a run-through.



Above :- Inside Bellair signal cabin.
Below:- Bellair station & goods shed



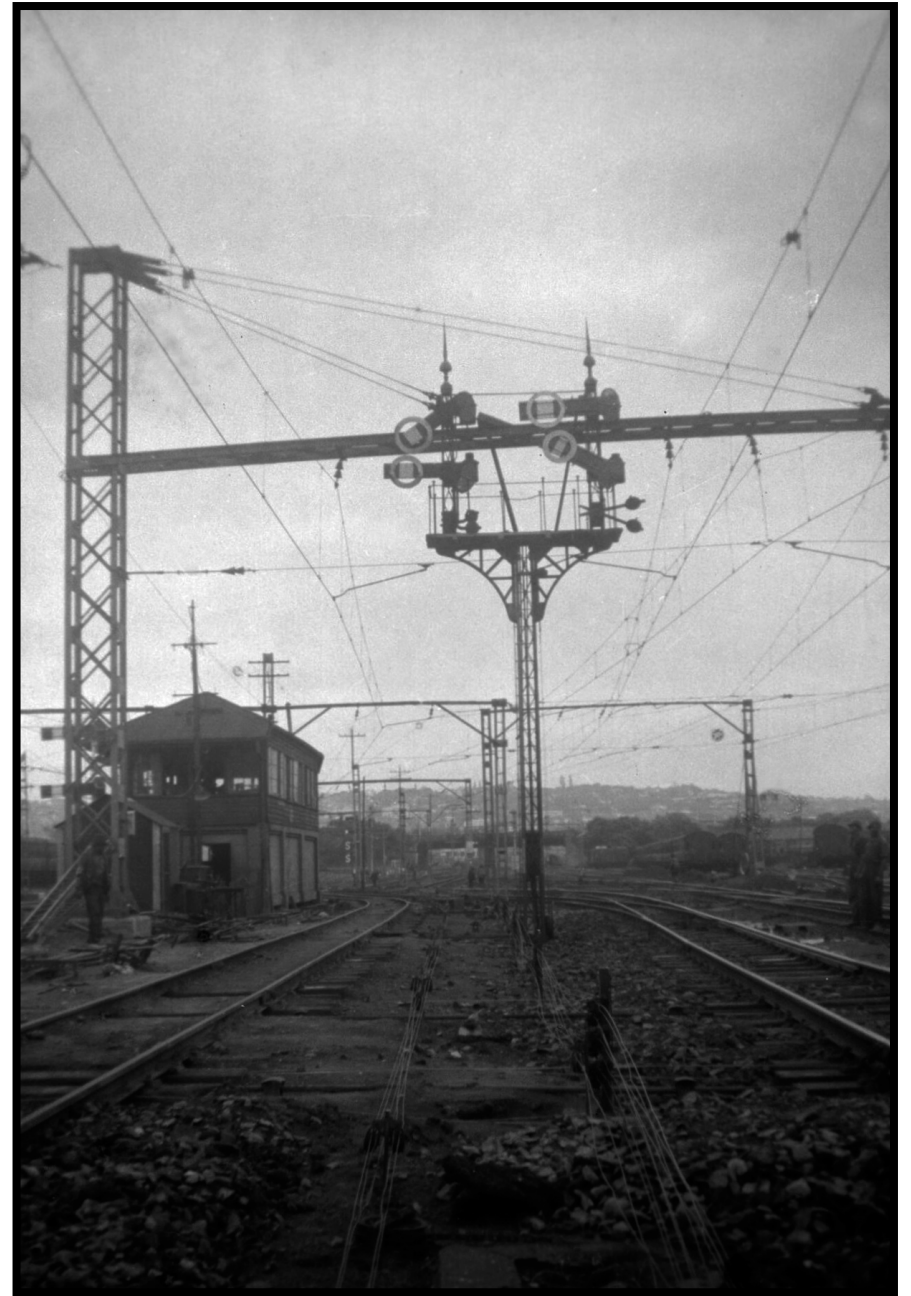
Bellair Station showing signalling in the N.G.R. days.



Bellair Home Signal



Above:- Pietermaritzburg North cabin in N.G.R. days.
Below:- Pietermaritzburg South cabin in N.G.R. days.



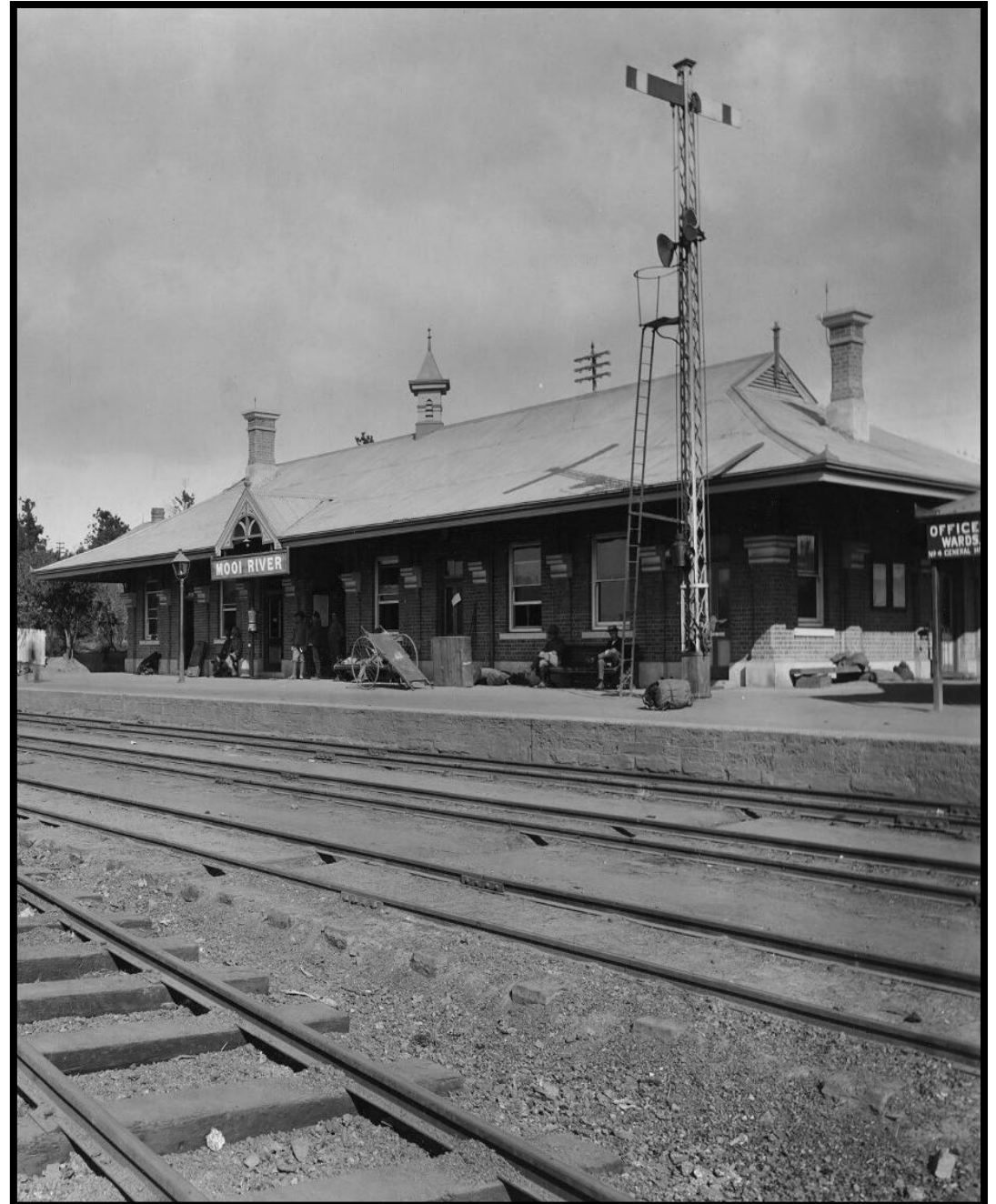
Durban station signalling in the conversion process,
from lower quadrant to upper quadrant.



Krantz Kloof station arrangement in the N.G.R. days.



Lidgetton station arrangement in the N.G.R. days.



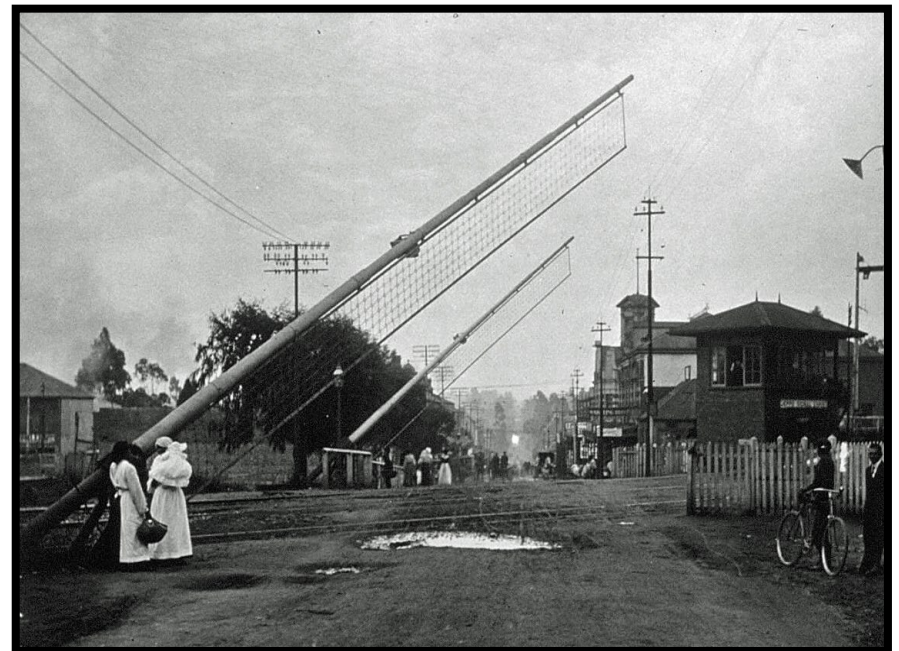
Mooi River station with N.G.R. signalling.



Above:- Driehoek cabin in C.S.A.R. days.
Below:- Congella cabin in N.G.R. days.



Above:- Denver cabin in C.S.A.R. days.
Below:- Jeppe level crossing cabin in C.S.A.R. days.





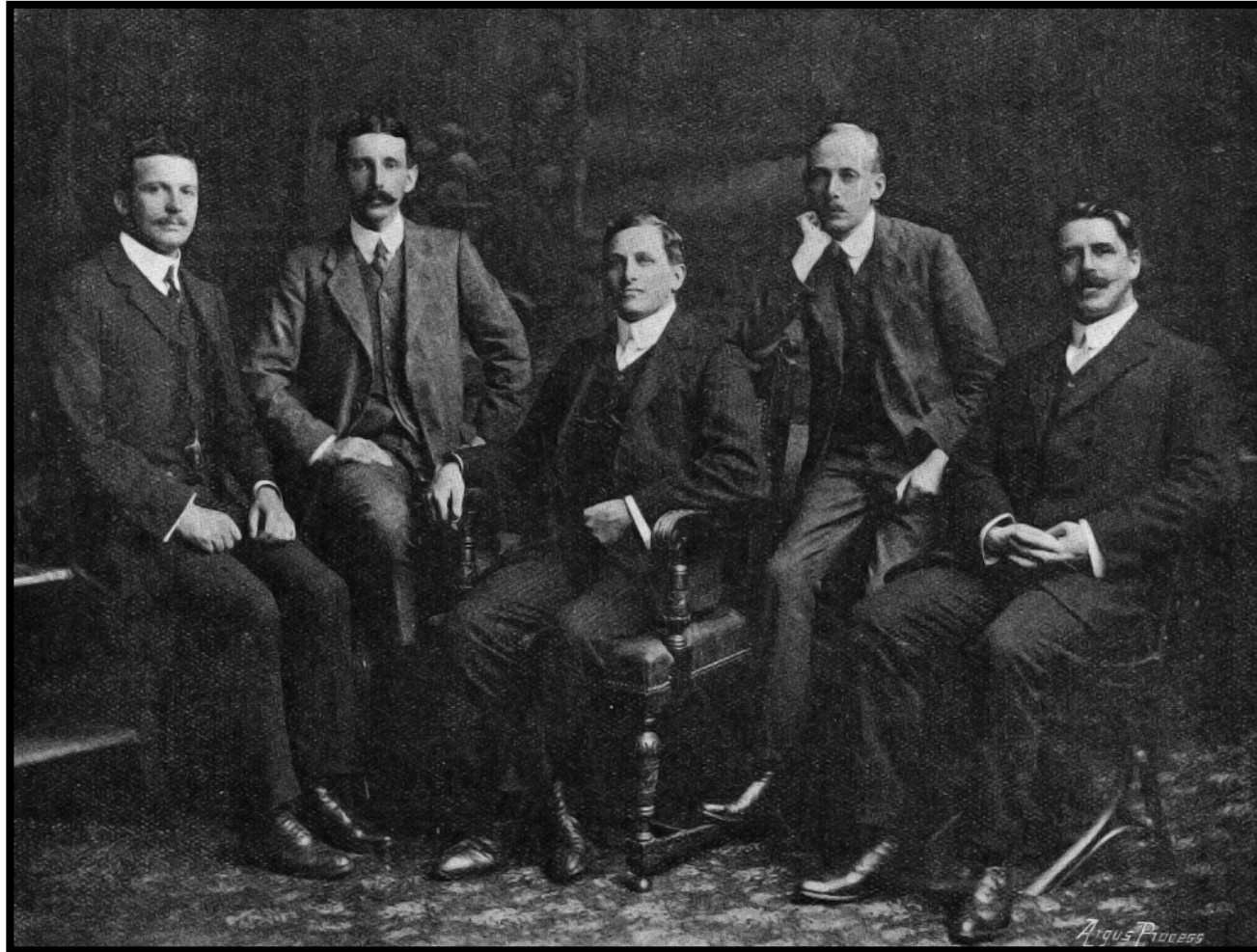
Above:- Salt River power frame.
Below:- Johannesburg power frame.



Above:- Standard pull-over frame at Booyens.
Below:- Standard pull-over frame at Rietfontein.



S.A.R. Signalling Officers Conference, Johannesburg, October 1910.



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